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THUNDER AND LIGHTNING.

THE violent thunderstorm which swept over the middle and south of England last week, and which expended its full fury with fatal effect upon the Metropolis, calls attention once more to a subject the importance of which can scarcely be over-estimated, but which has been strangely neglected. More than a century has passed since the efficacy of lightning conductors in the protection of buildings was demonstrated; yet there is still a curious ignorance as to their use and value, and seemingly a considerable degree of indifference as to whether they are employed or not. Perhaps the indifference of to-day is the reaction from the religious fervour with which, in some countries, their erection was opposed one hundred and ten years ago. Be that as it may, it is needful that more thought should be given to the subject, both in the interests of humanity and for the protection of property.

The destruction annually caused by lightning is of much greater extent than is generally supposed: the instances of loss of life are usually isolated—one here, another far away—and consequently the fact that they are really numerous in the bulk is not observed. During the months of July, August and September in the year 1884 there were several severe thunderstorms, and in that period 35 people were known to have been killed in the British Islands, while 91 others were in some way injured. In the same time the newspapers gave accounts of the death by lightning of 44 horses, 181 oxen and 239 sheep. It has been estimated that about 100 people are annually killed by lightning in the United Kingdom. By the one storm of Wednesday last week we already know that five people were killed, and a general examination of British newspapers would doubtless reveal a very considerable destruction of live stock and other property.

There will always be a difficulty, of course, in protecting animals in the field from lightning strokes, for they persist, when a storm comes, in gathering, where possible, in the shelter of trees, and to affix a lightning rod to every tree on a farm or estate would be rather an expensive, if not a Quixotic, undertaking. But the money loss sustained through injury to buildings of various kinds is probably greater than that caused by the death of cattle, although statistics are in the former case much less easy to procure. If the danger is greater, the remedy is more readily applied. Lightning rod construction deserves to be a much more flourishing industry than it is, seeing what immense benefits it is capable of affording. Practical immunity from injury is the certain consequence of the erection over a building of a properly-constructed lightning rod; provided, of course, the erection is carried out in an efficient manner and in compliance with certain well-known physical laws. Yet the proportion of costly and important edifices entirely unprotected in this regard is appallingly large. Some of the finest cathedrals and churches of England have no lightning conductors whatever, while others are insufficiently and improperly furnished with them.

Not only is it necessary to call attention to the lack of conductors; faulty and ignorantly put-up rods are exceedingly numerous in comparison with the total number in existence. Many accidents are upon the record which have been due to the bad construction of lightning conductors, churches being the most notable sufferers from this cause. The history of St. Bride's church in Fleet Street affords a curiously complete illustration of the need of lightning conductors for lofty buildings and of the need also that those conductors shall be good ones. On a Sunday afternoon in June, 1764, fourteen years after Franklin's discovery of the identity of lightning with electricity, but several years before St. Paul's Cathedral, the first public building in England to be so protected, was surmounted by a pointed lightning conductor, an intensely vivid flash of lightning struck St. Bride's beautiful steeple. The metallic weather-vane and the iron bars by which it was supported safely conducted the current some distance down the steeple, but at the spot where the bars terminated a number of huge stones were shattered into fragments. Other metal work afforded a broken path for the current, but the intervening stonework suffered great havoc. Ninety feet of the steeple had to be taken down entirely, while great and expensive repairs were required for the rest. Many years afterwards the steeple was again struck, and although a lightning conductor had in the interval been erected, it was so faulty in construction that at various points the church was once more damaged. In the storm which occurred at midday on July 15th last, St. Bride's a third time proved an irresistible attraction to the electricity of the heavens; fortunately upon this occasion the church itself was uninjured. The conductor conveyed the current to earth, but the contact was insufficient. There was a bad joint just below the spot where the rod entered the ground, and, as the dissipation could not take place with sufficient rapidity, a number of flagstones and a portion of the earth were torn up and sent flying to some distance. At least three churches in the Metropolitan district—Christ Church, Endell Street, Long Acre, St. John's, Walham Green, and Holy Trinity, Tulse Hill—were struck and damaged in last week's storm, and a large number of buildings of various kinds, in London and the provinces, were set on fire by the lightning.

From the circumstances related it will be seen that even in this age of advanced acquaintance with physical forces, knowledge is singularly confined and its practical application in a most beneficent direction limited to a degree that is lamentable. In the face of the rate at which our great buildings, of private as well as of public character, are multiplying, the apathy

which prevails in regard to their safety from lightning is remarkable, but possibly it is accounted for by the fact that thunderstorms are of short duration and occur only at long intervals. In the thankfulness for immediate escape, the advisability of preparing for the future is forgotten, and people proceed as though another storm and renewal of the danger were the least likely eventualities conceivable. It may be asserted that electrical engineers are as a rule well instructed as to the action of lightning, and as to the preventive and protective uses of lightning conductors. To them we commend the task of, as far as possible, enlightening their clients upon all suitable occasions —many of which occur in every engineer's practice— as to the great need for the protection of all exposed buildings from lightning and of the equal necessity that, whatever form of protection is adopted, it shall receive periodic inspection. This last point is a most important one: oxidation is liable to impair the efficacy of conductors in the course of a few years, so that care should be taken to ascertain their condition at frequent intervals.

AMERICAN journalists equal—perhaps excel—our own in the power of invention which they display when dealing with the work of the electrician. "A dispatch from Chicago" says that Mr. Pullman proposes to introduce there the system "now in vogue on one or two of the English railroad lines," of storing electricity for the lighting of the cars from the friction of the car wheels. We want to know where those "one or two English railroad lines" are situated, and also how they manage to store the electricity generated by the friction of the car wheels. Perhaps, however, someone had been trying to explain the Stroudley-Houghton system to the poor journalist, and he got a little mixed between "revolution" and "friction."

THE Edinburgh *Evening Dispatch* is dissatisfied with the remarks respecting long distance telephoning made by Mr. Raikes, the Postmaster-General, in reply to Mr. Jacob Bright in the House of Commons last week, and points out that the "cheap and swift" means of intercourse referred to by Mr. Raikes as already existing is also to be had on the Continent and in the United States, and that this has not prevented an amazing development of the telephonic system. Our contemporary's own experience of the use of the telephone between Edinburgh and Glasgow is that it is more expeditious than the telegraph.

THAT the construction of large arc lamps which will burn steadily is not easy of achievement must be evident from the paper on the "Isle of May Lighthouse" read by Mr. Stevenson before the Institute of Mechanical Engineers. Mr. Stevenson's original intention was to employ for the lighthouse a compound-wound Victoria dynamo and an automatically-fed arc lamp with the positive carbon below, but it was found that the Brush Company, after numerous trials, could not make a lamp of 30,000 candle-power to burn steadily with a current of 100 ampères and 70 volts. Experience seems to show that the range of E.M.F. through which a lamp will burn steadily with a continuous current decreases as the current increases. If the E.M.F. falls slightly, hissing and sputtering at once commence, while if it rises somewhat, a tongue of flame shoots out from the carbons and causes the light to vary in all sorts of beautiful but undesirable colours. According to our ideas, 70 volts is an E.M.F. too high for any lamp if steady burning is desired; but we think it will be found, on the other hand, that a steady arc will be obtained with any current if the E.M.F. is kept between 45 and 50 volts. Apart from the question of voltage, we have grave doubts as to the propriety of using a machine compounded for constant potential for the purpose specified. At all events, machine and lamp had to be discarded in favour of a De Meritens magneto and a Serrin-Berjot lamp.

THE De Meritens magneto machine is likely to be used for lighthouse illumination for a long time to come. Being a magneto there is no exciter required, and yielding alternating currents there is no bar collector with insulating strips of mica or plate commutator to keep in order. The current is collected by springs pressing on metal rings revolving with the shaft, and manifestly there are no repairs required save those which can be effected by an ordinary attendant with an average amount of common sense. In his paper on the "Isle of May Lighthouse" Mr. Stevenson gives the E.M.F. of each De Meritens machine as 80 volts on open circuit and 40 volts when 220 ampères are flowing, the speed being 600 revolutions per minute. This result differs from the test made by Prof. Adams on a similar machine, he finding the E.M.F. to be 75 volts on open circuit and 37 volts when 135 ampères were flowing. There must be a mistake here, for it is unlikely that the characteristics of two similar machines would show such great variation. For a description of the machines we must refer our readers to the papers of Prof. Adams and Dr. Hopkinson, read before the Society of Telegraph Engineers in 1884, and reported by us at the time.

WITH reference to our remarks upon search lights last week, a correspondent writes to say that "the projector will be the first target at which in actual engagement an enemy will fire. From its exposed position it makes a splendid mark and its locality can be easily distinguished by tracing the beam of light, always visible, to its source. It is impossible to predict how maritime warfare will be influenced by the modern 'resources of civilisation' until an actual engagement takes place. These resources may prove valuable or otherwise, but the longer the demonstration is postponed the better, and meanwhile, our attention may be devoted to building torpedo boats which won't break down." We would refer our correspondent to the account of Captain Hawkins's experiments given on another page.

AS regards primary batteries, "the cry is, still they come!" Never, we think, have there been such times for batteries. After the "Eclipse," which has eclipsed everything in pure British "cheek," comes the Schanschieff Electric Battery Company, registered with a capital of £25,000. For the benefit of intending investors in primary battery shares we give a little anecdote which is rather *apropos* at present. Last year at the Dynamicables an evening was set apart for a discussion of the merits and demerits of primary batteries. Amongst others the Upward battery was brought prominently forward, and Prof. George Forbes was called upon to speak. It was evident that the Professor had been considering the question, for he had sat grave and moody during the discussion, apparently buried in the deepest abstraction. But being called upon, after a preliminary cough, he spoke, his speech being to the effect that notwithstanding all that had been written and spoken of primary batteries, if he were to light up his house he should use nothing but Grove's cells. They were a great nuisance and made an awful mess, but he had yet to learn that batteries subsequently invented were less of a nuisance or less messy!!! Prospectuses please copy.

EXPERIMENTAL RESEARCHES ON THE ELECTRO-DEPOSITION OF ALLOYS.

By ALEXANDER WATT.

BELIEVING that this subject has not been so thoroughly investigated as its importance would merit, I resolved to pursue a series of experiments to determine which metals, and under what conditions, would deposit, in the form of alloys, upon other metals from various solutions, setting aside all those electrolytes (cyanide solutions) from which brass, German silver and coloured golds are deposited in the ordinary operations of the practical plater. I may state that my experiments were conceived more with a view to ascertain facts than to discover new processes which might be applicable to the Arts. Although these experiments had no practical significance in their inception, it is possible, however, that some of the results obtained may prove useful, not only to persons engaged in electro-deposition, but also to those occupied in that important branch of the subject now recognised as "electro-metallurgy."

In preparing a series of solutions of mixed metals for electrolytic treatment, I was not unmindful of the law of Berzelius, that "out of a solution of mixed metals, the least electro-positive metal is deposited first," but as I had met with results in practice which tended somewhat to weaken my confidence in the accuracy of this law, I resolved to disregard it for the time and try, by actual experiment, whether it was reliable, or otherwise. I was also aware that Professor Silvanus Thompson had somewhat recently read a paper before the Royal Society on the "Electro-deposition of Alloys, and on the Electromotive forces of metals in cyanide solutions," in which he held, in reference to the electro-deposition of brass, bronze and German silver from cyanide solutions, that this was "apparently departing from the law of Berzelius, that out of a solution of mixed metals, the least electro-positive metal was deposited first." In the same paper Professor Thompson states "it is well known that the electro-deposition of such alloys as brass, bronze and German silver is not practicable from mixed solutions of the sulphates or chlorides of the constituent metals." Again, Gore says: "With a solution of mixed sulphates of zinc and copper, copper anode and cathode, and a single small battery, copper alone was deposited; zinc was strongly positive to copper in this liquid by the galvanometer, and coated itself immediately with copper in it by simple immersion;" and he further adds—though why he should claim credit for the discovery it is difficult to imagine—"From these and many other experiments which I have made with similar results, we deduce the following rule:—If a liquid contains several metals or electro-positive substances, and a *weak* electric current is passed through it, only that substance which is least electro-positive will be deposited."

Having quoted the above authorities to explain what is recognised as the governing principle in connection with the electro-deposition of alloys, I may now state that, so far as my own experiments have shown, the law of Berzelius is not sustained. Indeed, the results which I have so far obtained, appear to me to render the "departures" from this law rather the rule than the exception. In order to render my experiments as uniform as possible, I employed the same number of battery cells in each case, and as the battery was very constant, and, I should add, very weak, there was practically no difference in the conditions under which each result was obtained. In following up the subject, I determined—1. To ascertain if an alloy could be obtained from acid solutions by means of a direct current. 2. Whether an alloy could be obtained upon a piece of metal by contact with another metal in the same solution. 3. Whether the same solution would yield an alloy *by simple immersion*. Under the two latter conditions of working I may say that I obtained results which, so far as my rather extensive practical experience is concerned, I was quite unprepared for. I may here remark that in the electro-deposition of alloys—brass for example—great care is necessary to prevent one or other of the constituent metals (zinc and copper) from depositing alone. I have known an instance, when working a cyanide brassing bath, in which an iron rod, suspended horizontally in the bath, received a coating of copper at one end, zinc at the opposite end, and brass of various shades of colour on the intermediate surface. Again, in the same solution, with a large anode surface immersed, zinc alone would deposit; with very small anode surface, copper alone, and when the electrodes were properly balanced (not necessarily of equal surface, however) the requisite alloy—brass—was deposited of a fine golden colour, provided that the cathode remained stationary in the liquid; if, on the contrary, the article was moved briskly about in the bath, copper alone would be deposited. Bearing these facts in mind, great care was taken, in carrying out the experiments under consideration, to secure the best possible conditions of working, by making such modifications as were necessary in each individual case. Moreover, since too strong or too weak a current would have produced the same results as those above indicated, care was observed to avoid error from this source.

EXPERIMENT I.—*Citrates of Copper and Zinc.*—A mixed solution of these salts was prepared, the latter salt being in excess. The solution was moderately strong, and was used cold. Five small battery cells (zinc and copper elements) in series were used. This battery, having been in use for several weeks, gave a very feeble current, but amply sufficient for the purpose. With small anode surface copper alone was deposited; with large anode surface zinc alone. When these differences were adjusted, and the suitable anode surface arrived at, the cathode—a plate of steel—received a coating of *brass*. Finding that the deposition of an alloy, *from an acid solution*, presented little or no difficulty, and verified my belief that electro-negative and electro-positive metals would deposit together in the form of an alloy, if the proper conditions of working were established, I resolved to pursue the subject on the same lines, through a series of experiments with acid solutions, and with various metals, the results of which I now desire to make known.

By Contact with another Metal.—A plate of steel, placed in contact with a strip of zinc in the citrate of copper and zinc solution, received a coating of brass of good colour on the *contact* side and copper only on the opposite side.

By Simple Immersion.—A clean strip of zinc received a yellow coating of brass immediately, and continued to do so after several immersions.

II. *Acetates of Copper and Zinc.*—A mixed solution of these salts was prepared, with the latter in excess, and worked at various degrees of concentration until the desired object was attained, namely, the deposit of an unmistakable alloy. When the solution was too strong, a powdery deposit of copper alone appeared upon the cathode; gradual dilution, with water, however, soon improved the character of the deposit, and eventually put the liquid in a proper condition to yield a deposit of brass. To obtain a coating of brass of good colour from this solution, it was found necessary to immerse what may be considered a remarkably small surface of anode, that is to say, less than one-fourth of an inch of anode surface only was required to secure a coating of alloy upon a cathode surface (a steel plate) equal to at least 5 square inches. When the anode was allowed merely to touch the surface of the solution the steel plate instantly became coated on both sides, with brass of a good yellow colour, except at the extreme end, farthest from the anode, which was tipped with zinc only. To regulate this, and place the anode opposite the entire length of the steel plate, a piece of thin brass wire was employed as an anode, and answered the desired purpose in every respect, for a freshly prepared steel plate, soon after immersion in the bath, became uniformly coated on both surfaces with brass of a very good colour. Under these conditions the de-

position of a genuine alloy was far more prompt than with an ordinary cyanide brassing solution.

By Contact.—A steel plate, in contact with a strip of zinc, immediately received a coating of brass on the contact side, but copper alone was deposited on the opposite side.

By Simple Immersion.—A clean strip of zinc became coated with brass immediately after immersion in the above solution.

III. *Sulphates of Copper and Zinc.*—A solution was made with these salts, the zinc salt being in excess, and, as before, the liquid was tried at various degrees of concentration, water being repeatedly added until the twin metals deposited in the form of an alloy. While adjusting the strength of the solution care was observed to regulate the anode surface until the requisite colour of the deposit—yellow brass—was obtained. This point was not reached until the solution, by continued additions of water, had become exceedingly attenuated. In this state, however, a deposit of brass, of good colour, was received upon a steel plate, with the weak current from the 5 cells before referred to.

By Contact.—A steel plate, in contact with a strip of zinc, received a coating of yellow alloy in the above solution.

By Simple Immersion.—A clean strip of sheet zinc became coated with brass in the same solution by keeping the piece of metal gently in motion while in the liquid.

IV. *Chlorides of Copper and Zinc.*—In this case a very weak solution of the mixed metals was required to obtain a deposit of brass. When, however, the proper degree of dilution had been arrived at, an alloy of zinc and copper was received upon a steel plate, exhibiting the characteristic yellow colour of brass. The deposits from this solution, however, were not quite so readily obtained as with the former solutions.

By Contact.—Steel in contact with zinc received a coating of brass of an indifferent colour.

By Simple Immersion.—A yellow film, but not of good colour, was obtained upon a strip of zinc.

V. *Nitrates of Copper and Zinc.*—As in the last instance, an exceedingly weak solution of the mixed metals was necessary, otherwise a black, powdery deposit only was obtained. Even with a very dilute solution much difficulty was experienced in obtaining even a trace of yellow metal, the deposit being chiefly copper of a palish tint. Patches of a yellow colour were, however, visible on parts of the steel cathode, indicating the presence of an alloy.

By Contact.—A plate of steel in contact with zinc became highly iridescent in the above solution, the coloured film being very adherent. No alloy obtained by this method.

By Simple Immersion.—A strip of zinc immersed in the above solution received a black deposit only.

(*To be continued.*)

ELECTRIC LIGHTING OF ST. PANCRAS HOTEL.

THE installation of the electric light at St. Pancras Hotel is one of those which have been made without comment, and the very existence of which is unknown, except to those intimately connected with their introduction. The St. Pancras Hotel, a fine building, one of Sir Gilbert Scott's *chef d'ouvres*, is situate, as most of our readers know, at the upper end of the Euston Road, and forms a part of the Midland Railway Company's London terminus. So far only a portion of the rooms of the hotel have been lighted by electricity, although the building is one which commends itself to electric lighting. Its long corridors are unavoidably dark, and its deep massive walls all tend to render some sort of artificial lighting, even during the daytime, necessary. It may readily be imagined how objectionable gas is when employed as an illuminant, not only throughout the night, but often during the greater portion of the day, and it is surprising that gas should have been employed for so long a period with the electric light at hand. To the present energetic manager, Mr. Towle, is the wholesome change in a great measure due, and he must have earned for the company the thanks of many of his visitors for the comfort secured to them by the improvement.

The installation as it stands at present consists of some 250 lights of 16 candle-power, and the chief parts to which it is applied are: the grand coffee room, reading room, smoking room, one or two private rooms, the entrance hall, corridors, and main passages. There yet remain the music room, ladies' coffee room, and several private rooms, together with the whole of the bed rooms which are lighted by gas, and which will no doubt some day be brought under the influence of the electric light.

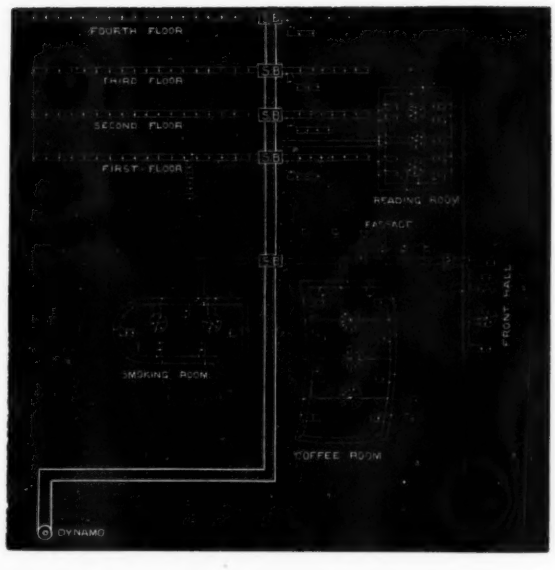
Want of space for engine power has been the reason for the limitation so far. As it is, what has been done has been effected only by rearranging and improving the power upon the premises. There existed, amongst others, two engines, erected originally for pumping and laundry purposes. One of these engines was set free for the use of the electric light, the heaviest and best (built by the company at Derby) being selected for the purpose. This is an horizontal engine of some 12 H.P. nominal. Space had to be found for the dynamo in the engine room, and as it could only be placed in one position, and that not a very desirable one in relation to the engine selected, it has to be driven from shafting. Good large leather link belting is employed, and no inconvenience beyond the slight loss of power attends this arrangement. The engine room being on the second basement, and immediately adjoining the boiler room, it may readily be understood that the position is not one of the best for the dynamo, the temperature of the room being always high. The engine is a slow speed one, but is provided with a heavy fly-wheel to which no doubt is due in a great measure the steadiness of the light. A pilot lamp is fixed on the dynamo, and there are others in the engine room. Opposite the dynamo is a switchboard, having upon it the main switch, fuse plug, ammeter, and voltmeter. With the object of enabling the engine man to keep a proper control of the engine, a bell is rung from the coffee room when any number of lights are turned on or off. The switchboard provides for placing the ammeter or voltmeter in circuit as required, and hourly tests, giving the speed of the dynamo, current, and E.M.F. are recorded during the time of working. The dynamo employed is one of Siemens's latest form, compound-wound, capable of affording a current of 120 ampères at 120 volts, at a speed of 640 revolutions; in practice, however, the speed does not exceed 625.

Covered cables are used throughout. Where they traverse the underground passages they are suspended from the ceiling open. On reaching the ground floor, they traverse boxing, divided so as to preserve the usual space between each cable. This boxing passes to the top of the house, and leads are taken from it at the several floors.

The building is fire-proof, the floors being divided by iron sheeting overlaid by concrete, the rafters of the flooring being laid upon the concrete. The masonry throughout is extremely close and heavy, and is therefore not highly favourable to electric wiring. By following the cornices, and by carrying one wire on either side of the corridors at the cost of some little additional cable, boring the massive walls has been avoided, the dryness of the walls insuring good insulation. In all instances the leads to the lamps are open, indeed, in scarcely any case are the wires covered in, all where it is possible being left open for inspection at any moment. The cables, being coloured to match the colouring of that portion of the cornice in which they are carried, present no objectionable appearance, whilst they afford every facility for examination when needed.

The manner in which the reading room is wired is, perhaps, worthy of notice. This is a highly ornamented

room, and to staple the wires on to the wall, or to fix boxing for their reception, would be a disfigurement to it. A wide band forms a portion of the cornice. Gilded flowerets some two inches wide have been fixed 12 inches apart along this band, and silk-covered wire of the necessary capacity run through grooves prepared in the edges of these flowerets. From these wires leads are carried to the electroliers. A similar course is pursued with regard to the private rooms, the covering of the wire corresponding with the colouring of the band of the cornice, or with the paper employed upon the wall, blends very nicely with the style of decoration, and is in no way disagreeable to the eye. The general arrangement of the wiring may be gathered from the accompanying plan. The fittings and electroliers are from Verity's, of Covent Garden. The coffee room is provided with three electroliers of 15 lights each, suspended from the roof, together with 18 bracket lights arranged around the room. The electroliers were made to drawings and designs submitted by Messrs. Verity and Son, and are provided with switches by which the lights can be turned in and out, five at a time. The switch in each case is arranged in a sphere which forms the body of the electrolier; the side lights are for the most part in twos, and are provided with small switches designed to match the gas fittings, each switch, of course, carrying its fuse. The lighting arrangements of this room provide for the use of either gas or electricity, the electric



installation being limited to that extent which does not admit of its being brought immediately into use should such at any time be necessary. The same remark applies to the smoking room. The reading room, however, is dependent entirely upon the electric light. The designs for electroliers in the reading room and main corridors were also from Messrs. Verity. The whole of the work has been carried out by the company's own department, and it is satisfactory to learn that it has proved in every way successful, and that no hitch has occurred in its running since it was started in March, 1886.

The lighting is brought into operation some half hour before dusk, and as a rule is shut off at midnight, after which hour gas lights are employed where required. Assuming that in winter time the lighting is started at 4 o'clock, and in summer time at 8 o'clock, we have on an average six hours running per day, or 2,190 hours for the year. The number of lights which started in March was something like 180, and the full complement was not reached for some three months following. Up to the present time 91 lamps only have been replaced, so that a large number of those in use have lasted considerably over a thousand hours. The lighting is good, but the voltage is kept down well within the limits of the lamp; the lamps employed are 110 volts, and the voltage measured at the engine room is not allowed to exceed 112, thus the E.M.F. at the terminals of the lamps never reaches 110, usually 108. The lamps employed are Swan's, fitted with the Edison screw. The following is a specimen of the diary and return kept by the dynamo man.

Time.	Amperes.	Volts.	Speed of Dynamo.
P.M.			
7.0	110	112	620
8.0	114	111	,,
9.0	110	,,	625
10.0	,,	,,	,,
11.0	,,	,,	,,
11.40	,,	,,	,,

From the plan it will be seen that switch boxes are provided on each floor, at which the necessary switches and fuses for the several branches are provided.

EXPLORATIONS OF THE MAGNETIC FIELDS SURROUNDING DYNAMOS.

(*Continued from page* 188.)

Fig. 3 shows a Sprague motor in which two neutral points were found near the far ends of two alternate coils, while none appeared to exist on the other coils. Unfavourable circumstances prevented the further examination of this machine, but it is quite probable that it would prove to be similar to the Edison machine in fig. 1, as there appeared to be two series-wound coils

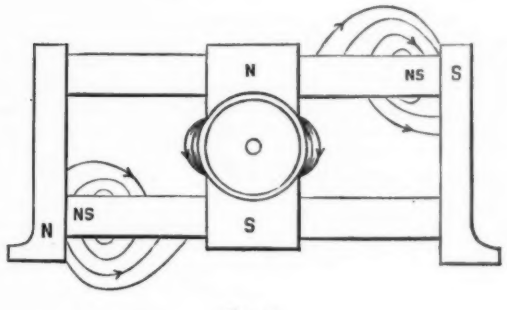


FIG. 3.

on two alternate magnets, and two shunt coils on the other two, which, unless the ampère-turns were equal in both, would cause unequal distribution of magnetism; the location of the two neutral points, as shown, indicates that this may have been the case with this particular machine while it was being examined. The unsymmetrical distribution is probably intentional in this machine, to accomplish certain results.

Fig. 4 shows the results obtained from a Van Depoele machine, the frame of which is of an entirely different class from those already shown. Only one-half is shown here; the coils surround the large massive cores which terminate each in one pole-piece. On the upper and lower side of the frame are two flat pieces which were presumably intended for yoke-pieces to magnetically connect the south pole at the right-hand end of the one core with the north pole at the other end of the other core. The exploration of the field, however, indicates that it performs the entirely different and very objectionable function of magnetically shunting the armature by inducing the otherwise useful lines of force to leave the edge of the north pole-piece and return through this intended yoke-piece to the south or right hand end of the magnet, thus acting

as a superfluous and objectionable yoke-piece to the two ends of the same magnet; the lines of force which should pass through the armature are therefore shunted off to one side. Furthermore, that portion of this flat piece which lies directly above the two pole-piece projections marked S and N, appears to short circuit, magnetically, these two pole-pieces, or, in other words, it magnetically shunts the armature, as a portion of the lines of force which should pass through the armature are led off around it and are, therefore, wasted. If this is as it appears to be, it might be better to omit these pieces altogether or to make them of some diamagnetic material.

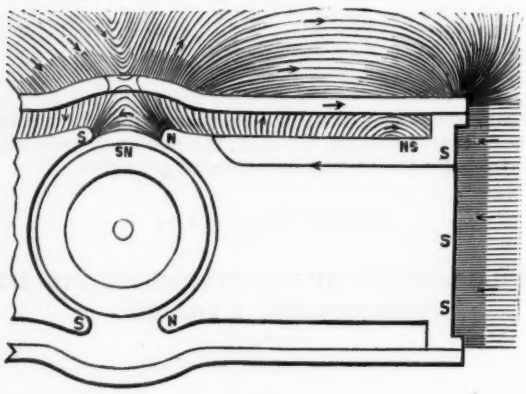


FIG. 4.

The strongest leakage appears at the two pole-piece projections, the leakage being into the intended yoke-piece. This leakage extends along the side of the coil, nearly to the neutral point, N S, which is near the farther end. The yoke-piece also exhibits a neutral point nearly above the one in the magnet and of the same polarity. As might be supposed, there is very intense leakage from the ends of the machine, the right hand end in the figure being a very strong south pole. But the leakage at this place does not necessarily represent wasted magnetism, as most of the lines of force which escape here no doubt pass through the armature after passing through the core of the magnet, and are therefore not wasted; their return course, however, is to a great extent through the air, thus making open circuit magnets as distinguished from closed circuit or iron-clad magnets in which the lines pass through iron along their whole course, and as the magnetic resistance of air is much greater than that of iron (according to Kapp 720 times that of iron) the magnetism must be weakened considerably in passing through so much air in its return circuit.

A peculiar field was noticed outside of the yoke-piece almost directly above the middle of the machine. In moving the exploring needle horizontally at this place it suddenly made an abrupt turn of about 90° and over, indicating a sharp turn of the lines of force at this point. Further examinations indicated that the lines of force had the direction as shown at this point, which can readily be explained on the assumption that there exists in the iron of the yoke-piece directly below these sharp curves, a point of deflection of magnetism or point of unstable magnetism as it was termed above, which has been indicated in the figure by four short curves. Not only do the lines of force all around this point indicate its presence, but in a very similar machine (fig. 7) the same point was shown to exist in nearly the same relative position, being in this case in the air instead of in the iron, and its existence could therefore be determined definitely. If lines of force form closed circuits in themselves it is probable that those which are deflected downward to this point without entering the iron, are the return circuits of those which leak out at the two ends of the machine.

The field around the Thomson-Houston machine, shown in figs. 5, 6 and 7, proved to be one of the most interesting, some of the curves being of a very peculiar nature. The magnetism was so intense in several places and the lines made such sharp turns that the exploring needle was repeatedly reversed in polarity during the examination, thus giving absurd results. It was not until the needle was repeatedly tested for polarity, and all results obtained with a reversed needle discarded, that any conclusive results could be obtained. The test was furthermore rendered difficult at first by the fact that the direction of the lines of force could not be tested in one plane only as in the other machines, as they curved around in different planes in such a way as to make it difficult to represent their courses on the plane of the drawing. In order to be sure that the results were correct the writer recently repeated the tests very carefully on a new 30-light arc machine, and obtained the results shown in the figures, which are believed to be substantially correct.

Fig. 5 shows more than half of the vertical cross-section through the centre, taken perpendicularly to the shaft. The coils are wound around the large, hollow cast-iron cores which terminate at the armature and at the ends of the machine, one of which is shown complete. There is a round opening in the thin shell which embraces the right and left hand sides of the armature. The intended yoke-piece consists of a series of horizontal, round, wrought-iron bars, two of which are shown, one above and the other below the armature. It is, therefore, similar in general outline to the Van Depoele machine in fig. 4, and the results should

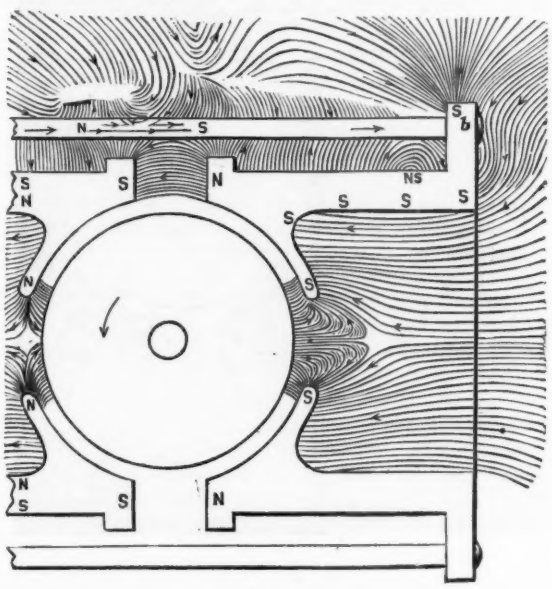


FIG. 5.

therefore agree to a certain extent with those shown in fig. 4, which was found to be the case. As in the Van Depoele, there was a very strong leakage from the magnets to the yoke-piece, especially at and near the ends of the pole-pieces, showing that many lines of force were magnetically shunted around the armature, and were therefore wasted. A neutral point was found near the right hand end of the core as shown. Immediately above the bars of the yoke-piece a strong field existed which showed the same polarity as that between the yoke and pole-piece, as indicated by the arrows, showing that these yoke-pieces had two strong poles one above each of the pole-pieces, but of opposite polarity to the latter. Immediately above this field and represented by an open space, the needle exhibited that peculiar state of unstability indicating a point of deflection, while above this space it again had a definite and decided direction. In this space, left blank on the fig., the lines were found to be perpendicular to the plane of the drawing, as is shown more clearly in fig. 6, which is an enlarged vertical cross-section taken

through the north pole-piece perpendicular to the bars of the yoke-piece. As shown in this fig. the lines passed from the pole-piece into the yoke-piece on all sides, while the others from the pole-piece pass out into the air between the bars, thus forming above the bars at about the relative distance shown, a point of deflection having four poles, similar to that in the Edison and Weston machines.

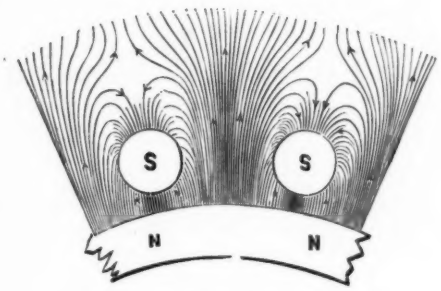


FIG. 6.

Referring again to fig. 5 a peculiar deflection of the lines was noticed almost directly above the south pole-piece, which was somewhat similar to that observed in the Van Depoele machine. It is possible that this was due to another point of deflection existing in the iron, as indicated in fig. 5, with four or possibly six poles, but these curves in the iron itself are probable conjectures only. A similar deflection was noticed a few inches to the left of this point.

In moving the exploring needle vertically above the north pole-piece, it was found to turn abruptly through almost 180° a few inches above the yoke-piece, as shown by the arrows, while nearly above this there was a deflection similar to that in fig. 4. This was found to be due to a point of deflection existing between the bars but above them, and is shown more clearly in fig. 7, which represents a portion of a section like fig. 5, but between the bars. This point was clearly indicated by the needle, and assists in connection with figs. 5 and 6, in explaining some of the peculiar curves noticed above that part of the yoke-piece which lies above the pole-pieces in fig. 5.

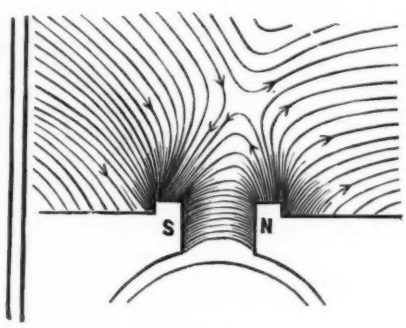


FIG. 7.

At the right hand end of the core the usual strong pole was found. A peculiar curving of the lines was noticed at *b*, where the rounded projections of the wrought-iron bars passed through the flanges. A possible explanation of this is, that the cast-iron flange is over saturated to a greater extent than this projection of the wrought-iron bar, which, therefore, attracts the lines.

Following the surface of the core to the inside or hollow portion, a weak south pole was found to exist on the cylindrical surface, while on the interior flange embracing the armature, the south pole was found to be very strong, the lines from it passing out through the open end. By placing a small needle very near the revolving armature and in the opening in the iron, it was found that many of the lines from this south pole entered the armature. From the general principles underlying all other dynamos, it would be supposed that the polarity of the pole-piece embracing the right hand half of the armature, was the same in all parts, but it appears from the external lines of force which could be examined, that this is not the case with this machine as there is a strong north and a strong south pole on different parts of the same pole-piece. Careful and repeated examinations with the exploring needle on the same and on different machines clearly show this peculiar disposition of poles to exist.

Near the opening through the centre of the core, was another point of deflection with four poles, which in some machines was found to be very near the armature, as shown on the left hand side, while in others it was located several inches from the armature as shown on the right hand side. The lines of force at this point were very intense, and their curved directions were very decided; for this reason it was found that a very short needle had to be used and that it had to be moved about very slowly to prevent it from having its polarity reversed before it could respond to the change of direction. By moving the needle rapidly from the armature through this point of deflection, its polarity can readily be reversed, and it will then point in the same direction as it did before passing the point, thus making it appear as if there was no point of deflection. Moving the needle toward the armature will not reverse it so readily, as these curves are less abrupt.

The lines of force at this point appear to oscillate very rapidly, which is probably due to the pulsating character of the magnetising current. If, therefore, a small induction coil in the form of a simple coil of copper wire, be held concentric with this opening in the core and near to it, an alternating current would no doubt be induced in it. A telephone in series with this coil will indicate the presence of such alternating currents by a buzzing sound, the note emitted being apparently dependent on the speed and number of coils of the armature.

It is quite probable that the curves shown in all these figs. would change very much with different degrees of saturation. A careful study of the curves of each machine at regularly increasing degrees of saturation, might lead to a determination of the best proportions and shapes of the iron parts.

Figs. 4 and 5 are good illustrations of how not to proportion the parts when the best economy of magnetisation is desired. At the same time it must not be forgotten that the energy used to excite the magnetism is for the best machines only a few per cent. of the whole out-put, and that, therefore, any improvements in the frame that would economise magnetism would only lessen this already small fraction, and possibly in some cases economise material. Other conditions may be of so much more importance as to make an increase in the economy of magnetism of little significance in comparison. The fact that the Thomson-Houston machines are used in such large numbers, shows that great economy of magnetism is not one of the most important points about a machine.

It is often represented as a good feature of a machine that its magnets are very powerful and will hold very heavy weights; a little consideration, however, will show that such external magnetism, especially when at the pole-pieces, represents leakage and waste, and, therefore, is an objectionable feature. It would be much more creditable to a designer of a machine to be able to show that when running with its full load the magnets will not even attract a small bunch of keys, all the magnetism being diverted into the armature where it is wanted.

From the nature of the fields surrounding a dynamo, as shown in the figs., the following general deductions may be made. That machines exhibit the following magnetic properties:—Free north and south poles, neutral points of two different polarities, and points of deflection; the latter exist in the external fields but may possibly exist also in the iron itself; they generally appear as four curvatures of the lines of force towards and receding from one point, and are in

that case enclosed by four free poles and four neutral points of alternately opposite polarity. That the lines of force in and around a magnet appear to have the following properties:—Like lines repel, unlike lines attract each; they never intersect; they appear to form circuits or paths closed in themselves and surrounding the current generating them; when not prevented by other forces they take the shortest distance between the iron parts. The illustrations of these statements in the special cases shown, is not offered as a proof of their correctness in all cases; they are given here only as general guides in exploring and plotting such fields.

SELF-INDUCTION AND ITS MEASUREMENT.

By E. C. RIMINGTON.

(*Continued from page* 183.)

To find the apparent joint resistance of the galvanometer and shunt.

Let x = the joint resistance

Then
$$C = \frac{E}{\rho + x}$$

Therefore
$$\frac{1}{p}\left(G + S - \frac{S^2}{\rho + S}\, e^m\right) = \frac{1}{\rho + x}$$

or
$$x = \frac{p}{G + S - \frac{S^2}{\rho + S}\, e^m} - \rho$$

Now x is evidently independent of the value of ρ, so let $\rho = 0$.

Then
$$p = G\,S \quad \text{and} \quad m = -\frac{G\,t}{L}$$

Therefore
$$x = \frac{G\,S}{G + S - S \cdot e^{-\frac{G\,t}{L}}} = \frac{G\,S}{G + S\left(1 - e^{-\frac{G\,t}{L}}\right)}$$

If $t = 0$,
$$e^{-\frac{G\,t}{L}} = 1.$$

Therefore
$$x = \frac{G\,S}{G} = S,$$

or the apparent resistance of the galvanometer at the moment of closing the battery branch is infinite.

If $t = \infty$, so that the currents have attained their permanent values
$$x = \frac{G\,S}{G + S}.$$

The above may be arrived at more simply by supposing $\rho = 0$ in the first instance.

In this case we have
$$C_1 = \frac{E}{G}\left(1 - e^{-\frac{G\,t}{L}}\right)$$
$$C_2 = \frac{E}{S}$$
$$C = C_1 + C_2 = E\left(\frac{1}{G} + \frac{1}{S} - \frac{1}{G}\, e^{-\frac{G\,t}{L}}\right)$$

Now
$$x = \frac{E}{C} = \frac{1}{\frac{G + S}{G\,S} - \frac{1}{G}\, e^{-\frac{G\,t}{L}}}$$
$$= \frac{G\,S}{G + S\left(1 - e^{-\frac{G\,t}{L}}\right)};$$

the same result as before.

To find the apparent multiplying power or n.

By definition of n
$$n\,C_1 = C$$

or
$$n = \frac{C}{C_1}$$
$$= \frac{E \cdot \frac{G + S\left(1 - e^{-\frac{G\,t}{L}}\right)}{G\,S}}{E \cdot \frac{1}{G}\left(1 - e^{-\frac{G\,t}{L}}\right)} = \frac{G + S\left(1 - e^{-\frac{G\,t}{L}}\right)}{S\left(1 - e^{-\frac{G\,t}{L}}\right)}$$
$$= \frac{G}{S\left(1 - e^{-\frac{G\,t}{L}}\right)} + 1$$

To find the ratio between the quantities passing through the galvanometer and shunt.

Taking equation (3)
$$C_2\,S - C_1\,G - L\frac{d\,c_1}{d\,t} = 0.$$

Multiplying up by $d\,t$ and integrating we have
$$S\int C_2\,d\,t - G\int C_1\,d\,t - L\int d\,c_1 = 0.$$

But $\int C_1\,d\,t = q_1$ and $\int C_2\,d\,t = q_2$ where q_1 and q_2 are the quantities passing through the galvanometer and shunt respectively. Also if the current through the galvanometer or C_1 begins and ends with the value zero $\int_o^o d\,c_1 = 0$.

Therefore
$$S\,q_2 = G\,q_1$$

or
$$\frac{q_1}{q_2} = \frac{S}{G}$$

So that the quantities divide inversely as the resistances though the currents at any particular moment may not do so. As a matter of fact, however, the quantity passing the galvanometer causes the needle to deflect momentarily, and the motion of the latter sets up an E.M.F. in the coils of the galvanometer which will diminish the quantity passing through it. We may investigate the effect approximately as follows:

The number of lines of force passing through the galvanometer coils will be proportional to the sine of the angle the needle makes with their plane, and we may say it equals $a \cdot \sin x$ where a is a constant depending on the coils and strength of the needle and x the angle between the needle and the coils. The E.M.F. induced in the coils by the motion of the needle will consequently be $a\frac{d \sin x}{d\,t}$. So we can write
$$C_2\,S - C_1\,G - L\frac{d\,c_1}{d\,t} - a\frac{d \sin x}{d\,t} = 0$$

Where C_1 is the current through the galvanometer, C_2 that through the shunt, and x the angle the needle makes with the coils at some instant, t.

Then
$$S\int C_2\,d\,t - G\int C_1\,d\,t - L\int d\,c_1 - a\int d \sin x = 0$$

Let δ be the throw on the galvanometer due to the passage of the quantity, q_1, through it. Then, supposing, as must be practically the case with a ballistic galvanometer, that the quantity which is discharged through the galvanometer and shunt passes during a time which is very short compared with the period of the galvanometer. $\int C_1\,d\,t = q_1$; $\int C_2\,d\,t = q_2 \int d \sin x = \sin \delta$; and $\int d\,c_1 = 0$, since we integrate be-

tween the limits of time zero, and the time when the galvanometer is at the end of its swing, and the current through the galvanometer at both limits is zero, as the velocity of the needle at the end of its swing is zero.

We have then

$$S\,q_2 - G\,q_1 - a \sin \delta = 0.$$

Now $\sin \delta = 2 \sin \frac{\delta}{2}$ approximately, if δ be fairly small; and $2 \sin \frac{\delta}{2} = b\,q_1$ by the theory of the ballistic galvanometer, where b is a constant which depends on the galvanometer coils, needle and the controlling field.

Therefore $S\,q_2 - G\,q_1 - k\,q_1 - 0$

where $k = a\,b$

$$q_1 (G + k) = S\,q_2.$$

Adding $S\,q_1$ to each side we obtain

$$q_1 (G + S + k) = S (q_1 + q_2) = S\,Q,$$

Q being the quantity which is discharged through the galvanometer and shunt.

Consequently

$$Q = q_1 \cdot \frac{G + S + k}{S},$$

or the multiplying power of the shunt $= \frac{G + S + k}{S}$, k being a constant dependent on the galvanometer, and not on the value of S, so that it have the same value for all shunts.

The effect of self-induction in a circuit is the same as if the resistance of the circuit, at the moment of starting a current in it, appears to be infinite, falling in value as the time proceeds, in the following manner. Let R be the real resistance of a simple circuit, and let C be the current in it at a moment, t, after closing the circuit.

$$C = \frac{E}{R}\left(1 - e^{-\frac{R\,t}{L}}\right).$$

Let R_1 be the apparent resistance of the circuit; so that

$$C = \frac{E}{R_1}.$$

Then, obviously,

$$R_1 = \frac{R}{1 - e^{-\frac{R\,t}{L}}}$$

When $t = 0$ $R_1 = \infty$; when $t = \infty$, $R_1 = R$.

In the commencement of these articles, L is said to depend on the geometry of the circuit and on its magnetic resistance. If the circuit contains iron, the latter quantity is a function of the current. Let k, μ, and L be the magnetic susceptibility, permeability, and the coefficient of self-induction of a circuit containing iron; let k_0, μ_0, and L_0 be their initial values; *i.e.*, their values when the iron is nowhere near saturation. Then, employing Frölich's approximate formula, we have

$$k = \frac{k_0}{1 + \sigma C};$$

where σ is a constant, generally known as the "saturation coefficient."

Now

$$\mu = 4\pi k + 1 = \frac{4\pi k_0}{1 + \sigma C} + 1 = \frac{(4\pi k_0 + 1) + \sigma C}{1 + \sigma C}$$

$$= \frac{\mu_0 + \sigma C}{1 + \sigma C}.$$

L is obviously proportional to μ, since the magnetic induction equals μH, where H is the magnetising field. So we may write

$$L = \frac{L_0 + \sigma C}{1 + \sigma C}.$$

Now as L is a function of C we have:

$$E = C R + \frac{d (L C)}{d t}$$

$$= C R + \frac{d}{d t} \cdot \frac{L_0 C + \sigma C^2}{1 + \sigma C}$$

$$E = C R + \frac{(1 + \sigma C)(L_0 + 2\sigma C) - \sigma (L_0 C + \sigma C^2)}{(1 + \sigma C)^2} \cdot \frac{d c}{d t}$$

$$d t = \frac{L_0 + 2\sigma C + \sigma^2 C^2}{(1 + \sigma C)^2 (E - C R)} \cdot d c$$

$$t = \int_o^c \frac{L_0 + 2\sigma C + \sigma^2 C^2}{(1 + \sigma C)^2 (E - C R)} \cdot d c.$$

Integrating and putting C_1 for $\frac{E}{R}$, we find

$$R\,t = \frac{L_0 - 1}{(1 + \sigma C_1)^2} \log_e (1 + \sigma C) - \frac{L_0 + 2\sigma C_1 + \sigma^2 C_1^2}{(1 + \sigma C_1)^2} \log_e \frac{C_1 - C}{C_1}$$

$$+ \frac{\sigma (L_0 - 1) C}{(1 + \sigma C_1)(1 + \sigma C)}.$$

This expression is far too complicated and unwieldy to be of any practical use; we may, however, write it

$$- R\,t = \frac{1}{1 + \sigma C_1} \log (1 + \sigma C) - \frac{\sigma C_1}{1 + \sigma C_1} \cdot \log \frac{C_1 - C}{C_1}$$

$$- \frac{L_0 + \sigma C_1}{(1 + \sigma C_1)^2} \log (1 + \sigma C) - \frac{\sigma (L_0 - 1) C}{(1 + \sigma C_1)^2} +$$

$$\frac{L_0 + \sigma C_1}{(1 + \sigma C_1)^2} \log \frac{C_1 - C}{C_1}$$

If now σ is so small in quantity that the first four terms may be neglected in comparison with the last, we have approximately

$$- R\,t = \frac{L_0 + \sigma C_1}{(1 + \sigma C_1)^2} \log \frac{C_1 - C}{C_1}$$

$$\log \frac{C_1 - C}{C_1} = - \frac{R (1 + \sigma C_1)^2}{L_0 + \sigma C_1} t$$

$$1 - \frac{C}{C_1} = e^{-\frac{R (1 + \sigma C_1)^2}{L_0 + \sigma C_1} t}.$$

$$C = C_1 \cdot \left(1 - e^{-\frac{R (1 + \sigma C_1)^2}{L_0 + \sigma C_1} \cdot t}\right)$$

Let us now proceed to consider the effect of self-induction in a circuit containing an E.M.F. which varies with the time according to some periodic law, such as the E.M.F. obtained from an alternating current dynamo machine. In a circuit of this kind the effect of self-induction is very important, and in some cases the current is more affected by a change in the value of the coefficient of self-induction than by a change in the resistance: this is particularly the case when the alternations succeed each other very rapidly.

It is usual to assume that the E.M.F. acting in the circuit is a sine function of the time, as this is one of the simplest periodic functions. It is found that in most alternate current dynamos, this is very nearly the case; and, as the true function is probably a complicated one not easy to obtain, and, when obtained, difficult to work with, the employment of the sine function is adopted and the results given by it are very fairly accurate.

Let us write the E.M.F. acting in the circuit at any time t or $E = E_0 \sin a\,t$; where E_0 is the maximum value of the E.M.F. and a is some constant. When $a\,t$ has the values, 0, π and 2π $E = 0$; when $a\,t = \frac{\pi}{2}$, E is a maximum and equals E_0, and when $a\,t = \frac{3\pi}{2}$, E is a minimum and equals $- E_0$.

Let i be the value of the current in the circuit at some instant t. (I have here adopted the notation, suggested by Mr. W. H. Snell, in the *Electrician*, of employing the letter C for currents due to continuous E.M.Fs., and the letter i for those due to periodic E.M.Fs.)

Taking the fundamental equation for a circuit possessing self-induction, viz :—

$$i = \frac{E - L\frac{di}{dt}}{R}$$

we have

$$i = \frac{E_0 \sin at - L\frac{di}{dt}}{R}$$

This may be written

$$\left(\frac{R}{L}i - \frac{E_0}{L}\sin at\right)dt + di = 0.$$

Then

$$i = e^{-\int \frac{R}{L}dt}\left\{\int e^{\int \frac{R}{L}dt}\frac{E_0}{L}\sin at\,dt + C\right\}$$

C being an arbitrary constant. (*Vide* Boole's Differential Equations, chapter II, article 10.)

$$i = e^{-\frac{R}{L}t}\cdot\frac{E_0}{L}\int e^{\frac{R}{L}t}\sin at\,dt + C e^{-\frac{R}{L}t}$$

Now putting b for $\frac{R}{L}$ and integrating by parts we have :—

$$\int e^{bt}\sin at\,.\,dt = \frac{1}{b}e^{bt}\sin at - \frac{a}{b}\int e^{bt}\cos at\,.\,dt.$$

Again

$$\int e^{bt}\cos at\,.\,dt = \frac{1}{b}e^{bt}\cos at + \frac{a}{b}\int e^{bt}\sin at\,.\,dt.$$

Therefore

$$\int e^{bt}\sin at\,.\,dt$$

$$= \frac{1}{b}e^{bt}\sin at - \frac{a}{b^2}e^{bt}\cos at - \frac{a^2}{b^2}\int e^{bt}\sin at\,.\,dt$$

or

$$(a^2+b^2)\int e^{bt}\sin at\,.\,dt = e^{bt}(b\sin at - a\cos at).$$

Therefore

$$\int e^{bt}\sin at\,.\,dt = \frac{e^{bt}}{a^2+b^2}(b\sin at - a\cos at).$$

Therefore

$$\therefore\ i = \frac{E_0}{L(a^2+b^2)}(b\sin at - a\cos at) + C e^{-\frac{R}{L}t}$$

This can be written

$$i = \frac{E_0}{L\sqrt{a^2+b^2}}\sin(at-\phi) + C e^{-\frac{R}{L}t}$$

$$= \frac{E_0}{\sqrt{R^2+a^2L^2}}\sin(at-\phi) + C e^{-\frac{R}{L}t}$$

(To be continued.)

Safety in Mines.—Mr. Ellis Lever has decided to renew his offer of £500 for a perfectly safe, practical, and efficient means of blasting without gunpowder. He has communicated his intention to the Home Secretary, and, on the condition that the Government will undertake the necessary tests and make the awards, he has offered to place in Mr. Matthews's hands £1,000, to be awarded in two premiums of £500 each—one for the best method of safe blasting in coal mines without the use of gunpowder, and the other for a perfectly safe system of electric lighting in mines to supersede the present so-called safety lamps.

ON THE THEORY OF THE DYNAMO.

By O. FRÖLICH.

(*Continued from page* 185.)

By means of these values the following observations, made at different speeds with an external resistance, were calculated according to the method given in the *Elektrotech. Zeitschrift* (1886, p. 65). There was found for a, the demagnetising action of the ring-current the mean value $a = 0{\cdot}0330$; the values of u were not observed, but calculated from P and J. The two last columns give the results of the calculation for P.

v	J	P	u	w	$\frac{fv}{1+\frac{a}{w}}$	$\frac{P_j}{1-\frac{a}{w}}$	P cal.	Δ P
840	240	100·2	0·417	0·410	185·7	81·6	104·1	+3·9
840	184	104·3	0·566	0·552	188·2	79·8	108·4	+4·1
840	115	109·0	0·950	0·918	191·2	77·8	113·4	+4·4
840	69·2	111·7	1·615	1·520	192·9	76·7	116·2	+4·5
840	0	115	∞	26·9	195·8	75·1	120·7	+5·7
740	235	—	0·343	0·335	161·8	83·3	78·5	−1·5
740	187	83·0	0·443	0·435	164·2	81·2	83·0	0
740	125	87·7	0·702	0·684	167·1	78·8	88·3	+0·6
740	72·5	92·0	1·265	1·21	169·4	77·1	92·3	+0·3
740	0	97·0	∞	26·9	172·3	75·1	97·2	+0·2
640	230	43·0	0·187	0·185	134·1	91·2	42·9	−0·1
640	190	47·5	0·250	0·248	137·0	86·5	50·5	+3·0
640	132	59·2	0·448	0·439	142·0	81·1	60·9	+1·7
640	67·5	68·2	1·01	0·975	145·8	77·7	68·1	−0·1
640	0	73·5	∞	26·9	149·0	75·1	73·9	+0·4

The agreement in the second and third columns is satisfactory; in the first column the calculated P are about 4 volts too high. If we take for the first column $P_j = 79{\cdot}0$, f and a as above, we find :

P calcul. 99·7; 104·1; 109·2; 112·1; 116·7

Δ P −0·5; −0·2; +0·2; +0·4; +1·7,

i.e., a satisfactory agreement. As will be shown below, the value of the limbs, P_j, depends on the position of the commutator, whilst the constant of the ring, f, depends thereon little or not at all. Hence we are led to the assumption that in the first series of observations the commutator must have acted otherwise, whether by different lubrication or by a different apposition of the brushes. The position of the brush-holder had not been changed.

That the value a really corresponds to the demagnetising value of the ring appears from the following experiments, in which the limbs of the magnet were excited by another machine and the ring ran in one set of experiments without a current, and in the other with the strongest possible current.

Ring without current; v = 820.

J_n :	5·22	3·70	2·69	1·45	0·90	0·58	0·18
	0·55	0·90	2·63	4·12	5·22,		
E_∞ :	118	109	94·1	64·0	43·3	31·0	13·0
	25·5	43·3	95·0	110	118		

Ring with a current; v = 820.

J_n :	5·27	4·58	4·01	3·15	2·13	0·98	0·56
	0·17	0·55	1·70	2·95	5·43,		
J_a :	240	240	240	240	240	200	147
	60	135	235	240	246		
P :	109·5	105·8	101·5	91·7	68·5	32·3	19·7
	7·9	17·5	54·2	84·0	110·0,		
E :	114·8	111·1	106·8	97·0	73·8	36·7	23·0
	9·2	20·5	59·4	89·3	115·3.		

If we plot out these observations, taking E and E_∞ as ordinates and J n as abscissæ, we obtain (see fig. 4) two curves running substantially parallel. We derive from them by graphic interpolation :

J_n :	5;	4;	3	2;	1;
E_∞ :	117·5;	112;	99·5	79·0;	47·5
E :	114;	107	94·0;	70·5;	36·5

But now

$$E = f \cdot \nu \cdot \frac{\mu \cdot m_n \cdot J_n - \frac{a}{P_{\frac{1}{2}}} \cdot J\,a}{1 + \mu \cdot m_n \cdot J_n - \frac{a}{P_{\frac{1}{2}}} \cdot J\,a}$$

whence

$$\mu \cdot m_n \cdot J_n - \frac{a}{P_{\frac{1}{2}}} \cdot J\,a = \frac{f \cdot \nu}{f \cdot \nu - E}.$$

FIG. 4.

and if

$$J\,a = 0,\ E = E_\infty,$$

$$\mu \cdot m_n \cdot J_n = \frac{f \cdot \nu}{f \cdot \nu - E_\infty}$$

therefore

$$\frac{a}{P_{\frac{1}{2}}} \cdot J\,a = \frac{(E_\infty - E) \cdot f \cdot \nu}{(f \cdot \nu - E_\infty) \cdot (f \cdot \nu - E)}$$

for a certain value of J_n. If we hence calculate a we have:

J_n =	5;	4;	3;	2;	1.
a =	0·044;	0·053;	0·042;	0·042;	0·032

or, as a mean $a = 0{\cdot}043$.

This value does not differ greatly from that found above: $a = 0{\cdot}033$; in considering the agreement we must remember that a appears merely as a correction value and hence cannot be determined with great accuracy.

If in all experiments we take into account the increased resistance of the ring with the speed, a will become smaller. But there follows from the latest experiments undertaken to determine a a smaller value of a, since the values of the electromotive force turn out larger when a ring-current (E) is present.

The agreement is therefore satisfactory.

G. KAPP—PHŒNIX AND CROMPTON MACHINES.

G. Kapp has published the characteristics of two machines, the Phœnix and the Crompton, and has appended to the former a calculation according to my formula, which turns out very unfavourably. The reason of the disagreement lies not in the nature of my formula, but in the manner in which it is applied by Kapp. If the constants of the formula are accurately calculated, we find the observations agree very well with the formula.

Kapp has founded his calculation upon two points of the curve, one situate about in the middle of the observation and one at an infinite distance, corresponding to the maximum of the magnetism. The latter has been not observed, but estimated arbitrarily. The only correct method of calculating observations according to a formula is the method of least squares. We then obtain the following results (in both machines the first observation, which is evidently influenced by remanescence, has been omitted), and we write with Kapp:

$$\frac{\xi_1}{2} = \frac{P}{\alpha + \beta \cdot P},$$ where P (exciting power)

corresponding to our $m\,J$, $\frac{1}{2}\,\xi_1$, and the number of the lines of force to our $f \cdot M$.

PHŒNIX MACHINE.

$\alpha = 4{\cdot}122$, $\beta = 0{\cdot}000\,546\,1$.

P	$\frac{\xi_1}{2}$ observed.	$\frac{\xi_1}{2}$ from F.	Error.	$\frac{\xi_1}{2}$ according to Kapp's curve.	Error.
3,840	594	617	+ 23	590	− 4
5,660	792	785	− 7	780	− 12
6,900	910	874	− 36	890	− 20
9,620	1030	1027	− 3	1030	0
11,240	1070	1094	+ 24	1085	+ 15
12,100	1130	1128	− 2	1105	− 25

Mean error, according to my calculation = 1·7 per cent.

Mean error, according to Kapp's curve = 1·4 per cent.

CROMPTON MACHINE.

$\alpha = 23{\cdot}74$, $\beta = 0{\cdot}00202$.

P	$\frac{\xi_1}{2}$ observed.	$\frac{\xi_1}{2}$ calculated from F.	Error.	$\frac{\xi_1}{2}$ from Kapp's curve.	Error.
3,300	112	109	− 3	98	− 14
3,800	112	121	+ 9	112	0
5,300	151	154	+ 3	150	− 1
5,700	161	162	+ 1	159	− 2
7,700	197	196	− 1	203	+ 6
8,820	223	213	− 10	221	− 2
9,050	221	215	− 6	224	+ 3
10,420	240	233	− 7	237	− 3
11,300	246	243	− 3	243	− 3
12,900	258	259	+ 1	249	− 9
14,060	258	270	+ 12	252	− 6

Mean error, according to my calculation = 2·5 per cent.

Mean error, according to Kapp's curve = 2·25.

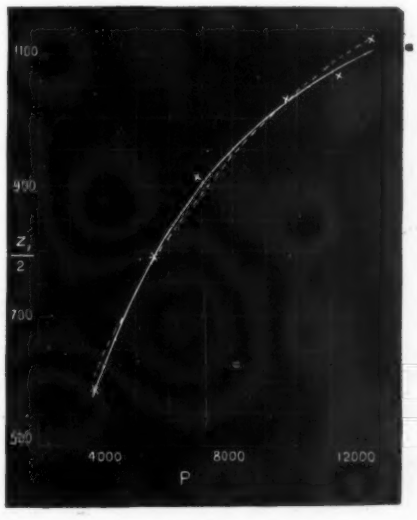


FIG. 5.

In figs. 5 and 6 the results are represented graphically; the unbroken lines are those of Kapp and the dotted lines those calculated according to my formula.

In both cases the accuracy of the results, according to my formula, is little inferior to those furnished by Kapp's curve. There can, therefore, be no foundation for Kapp's charge of the uselessness of my representa-

tion for his machines. On the contrary, I must thank Mr. Kapp for giving me the opportunity of including two new systems of machines in the group of those to which my formula can be applied with satisfactory accuracy.

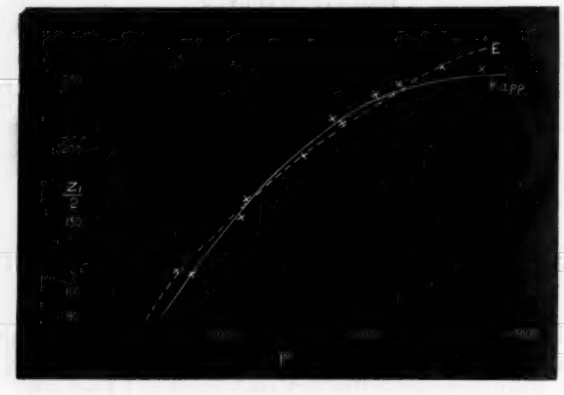


FIG. 6.

VON WALTENHOFEN, PEUKERT, ZICKLER, SCHUCKERT'S MACHINES.

Experiments were made with this machine which confirmed the properties of the current curve and the demagnetising action of the ring. (See *Zeitschrift fur Elektrotechnik*, 1885, p. 548.)

Subsequently (*Ibid.*, 1886, p. 450) experiments were made on the same machine with the limbs of the magnets placed parallel, and there was found a decidedly smaller value for the constant of the ring f (0·029 instead of 0·059). Hence Waltenhofen infers that the value of f also depends on the arrangement of the limbs, and that f, therefore, has not the signification of a ring-constant.

This conclusion is not justified, because in the experiments the increase of the ring's resistance with the speed of rotation is not regarded. But the latter is of so much more importance the more the wrappings of the limbs are placed parallel, *i.e.*, the fewer coils the limbs have.

Experiments are described below from which it appears that if this increase is taken into account the value of f does not turn out essentially different, and its designation as the "ring-constant" is therefore justified.

If we calculate from the observations given on p. 456 (reference to the *Elektrotechn. Zeitschrift*) how much the increase of the resistance of the ring must amount to that the agreement between calculation and observation prevailing for $f = 0{\cdot}059$, we find the increase for 1,780 rotations = 0·99 ohm, which, with a resistance of the ring when at rest of 0·294, amounts to a doubling of the resistance for 529 rotations. But this, according to my experience, is a quite possible value; I have observed both decidedly higher and decidedly lower values. This explanation has, therefore, a great probability, and it is very desirable that this increase of resistance should be determined by special experiments.

A proof that the constant, f, depends on the wrapping of the limbs of the magnets has, therefore, not yet been furnished.

Von Waltenhofen has further caused careful experiments to be made on a Schuckert machine, which Peukert has described and calculated (*Central Blatt für Elektrotechnik*, 1887, p. 2). It appears that my formula given without regard to the action of the ring.

$$P = f \cdot \nu \cdot \frac{w}{W} - P_i \qquad (1)$$

does not agree though the formula derived from it with regard to this action does so—

$$P = f \cdot \nu \cdot \frac{w}{W} = \frac{P_i}{1 - \frac{a}{w}} \qquad (2)$$

If we work at a constant speed the curves of polar tension run out in right lines by which Peukert, setting out from the first formula determines the constants f and P_i; the values obtained vary, however, for every speed, and differ enormously from that obtained with the corrected formula (2).

The reason is not that the first formula is altogether inapplicable—the contrary of which has been satisfactorily shown by observations—or that the constants thus obtained are not f and P_i, but something quite different.

(To be continued.)

THE SYNCHRONOUS MULTIPLEX TELEGRAPH SYSTEM.

IN the year 1884 a committee of the Franklin Institute, America, awarded the Elliot Cresson medal to Patrick B. Delany for his synchronous multiplex telegraph system, and also awarded to Paul La Cour the Scott legacy medal, on the ground that he was the inventor of the phonic wheel upon which, as a basis, Delany founded his system of multiplex telegraphy. No credit was given to La Cour for any device to produce synchronism between two phonic wheels, because the committee considered that not even approximate synchronism had been or could be produced by his apparatus. The committee emphasised the fact that the essential feature of Delany's system was its practically perfect synchronism, and that without this multiplex telegraphy by means of the phonic wheel would be impossible. At a meeting of the Institute, held on September 15th, 1886, a communication was received from Paul La Cour protesting against the award of the Elliott Cresson medal to Delany on the ground that La Cour had himself invented the system. A copy of the protest was forwarded to Delany, who replied, and at a meeting of the Institute both communications were referred to the committee, who addressed enquiries to the leading telegraph officials of Europe to ascertain what, if anything, was known of La Cour's apparatus prior to the date of the patents issued to Delany, and up to the present time. As the result of the inquiry the committee reported that "they find no substantial reason for revoking the award of the Elliott Cresson medal to Patrick B. Delany, already approved by the Institute."

There is, of course, a natural tendency for a committee under the conditions in question to avoid, by every possible means, having to rescind a previous decision; in other words, to avoid acknowledging that a mistake has been made; but we have seldom come across such lame and inadequate reasons as have been made by the committee of the Franklin Institute in the case of La Cour and Delany. Thus, a claim having been made by La Cour—that two circuits over one wire were worked successfully in opposite directions by means of his synchronism, based upon his phonic wheel, between Fredericia and Nyborg, Denmark, a distance of 40 miles, in June, 1880—an inquiry was addressed to the managing-director of the Danish Government Telegraphs, and the following reply received:—

Direction des Télégraphes d'Etat de Danemark.
Copenhagen, *February 9th*, 1887.

Dear Sir,—In reply to your letter of January 24th, I have the honour to inform you that in the year 1880, during the twenty-four days from the 17th June to 10th July, arrangements were made on the telegraph offices of the Danish Government, at Fredericia and Nyborg, for sending two messages simultaneously over one wire by means of Morse apparatus and separate circuits produced by "phonic wheels," invented by Paul La Cour as synchronous instruments.

I regret that I have not seen the experiments myself, but I am in possession of a diary, held by an officer of the Danish telegraphs, whereby it is stated that during that time, from the 17th June to the 10th July, 1880, the "phonic wheels," in Fredericia and Nyborg, were working every day from 8 or 9 in the morning

to 9 in the afternoon, only with a few short interruptions caused by several events, such as disturbances on the telegraph wire, or mechanical disturbances on the "phonic wheels." For the period from the 22nd June to the 10th July, it is expressly remarked that the synchronism was "good."

I am further in possession of official reports, dated 28th June, 1880, from the head officers of the telegraph offices at Fredericia and Nyborg, after which the apparatuses on the both offices have been working regularly, and messages have been sent since the 17th of June, except two days when the working of the "phonic wheels" was disturbed by mechanical causes. In these reports it is especially stated that on the 27th June, 1880, were sent *over one wire*, from 9 hours 57 minutes to 10 hours 19 minutes simultaneously, four messages on each of the two circuits from Fredericia to Nyborg, eighty words on the one and seventy-seven words on the other circuit. From 10 hours 20 minutes to 10 hours 36 minutes simultaneously, four messages on each of the two circuits from Nyborg to Fredericia, sixty-eight words on the one circuit and sixty-three on the other. From 10 hours 48 minutes to 11 hours 2 minutes, simultaneously, four messages (sixty-eight words) from Nyborg to Fredericia, and four messages (sixty-five words) from Fredericia to Nyborg.

These messages, as well as the paper slips, such as received at the office of Fredericia, are in my hands.

After this, there is no doubt, that in the year 1880, in this country, messages have been sent simultaneously over one wire by means of separate circuits produced by the "phonic wheels," invented by M. Paul La Cour. Before that time there was not, nor has there ever since been any telegraph line in this country operated by synchronism as a multiplex system.

With great respect, I remain,
Very truly yours,
(Signed) ————*
Director of the Danish Public Telegraphs.

Mr. E. Alex. Scott, Chairman of Committee
of the Franklin Institute, Philadelphia.

It will be noticed in the letter that the statement is made "for the period from June 22nd to July 10th, it is expressly remarked that the synchronism was 'good.'" The Franklin Institute Committee, however, decide from this letter that "the tests conclusively show that there was no synchronism nor even approximate synchronism," in fact, in plain language they give the lie direct, a proceeding which, to say the least, savours of a breach of good manners. The given conclusion arrived at is based on the fact that the statistics when analysed apparently show that only a speed of four words per minute per circuit was attained; in fact, it is stated that "the words actually sent and received were caught by the lucky operator during the brief moments when the instruments had drifted together and before they had separated again; and it may be remarked here that the more they were out of synchronism the oftener they would drift together." If the foregoing statement relative to the synchronism were correct it would mean, not that many of the signals would be lost, but that those intended for one circuit would be received on another, a result which would produce such confusion that no messages at all would be decipherable; this, however, was clearly not the case.

In comparing the synchronism systems of La Cour and Delany, the committee say of the former that:—

The wheels are *compelled* to be out of synchronism all the time. It is not even close enough to be approximate synchronism, and it would be impossible to use such a system even for duplexing a line, to say nothing of creating a greater number of circuits.

Delany having found La Cour's method impracticable, abandoned it, and set about constructing a new system by which each wheel kept the other from running irregularly, not by bringing it back after it had gotten out of synchronism, but by preventing it from getting out, the slightest tendency to go out being immediately checked.

The latter paragraph we unhesitatingly say is simply nonsense. In the Delany system, as in that of La Cour, the correcting arrangement does not come into action until the wheels are *out* of synchronism, and to say that they are prevented from getting out by being put right when they are out, is a statement worthy of an inhabitant of the Emerald Isle, though scarcely of a scientific committee.

We do not wish to underrate the work of Delany, as this gentleman has undoubtedly brought to a great state of perfection the comparatively crude ideas of La Cour, but the germ and something considerably more than the germ of the present system was originated by La Cour.

A great point is made by the Institute Committee relative to the method by which Delany disposes of the static charge from the line by the introduction of alternate ground segments between the line segments; with reference to this we may remark that this arrangement is by no means such an effectual cure as appears to be imagined, indeed, we believe that in this country a most material modification of the arrangement has been found necessary in order to make the apparatus work properly on long lines.

* Signature illegible. (W.)

ON THE MIGRATION OF IONS AND AN EXPERIMENTAL DETERMINATION OF ABSOLUTE IONIC VELOCITY.

By DR. OLIVER LODGE.

(*Continued from page 498, Vol. XX.*)

The following abbreviated excerpts from Laboratory Note-books will sufficiently illustrate the results so far attained.

Specific Gravity Data.—11·73 grammes of crystallised baric chloride added to 88·27 grammes of water give a solution of sp. gr. 1·095, containing about 10 per cent. of the salt itself. One-thirtieth of its bulk of water added reduces it to 1·093. 22·68 grammes of crystallised sodic sulphate added to 77·32 grammes of water give a solution of specific gravity 1·093, likewise containing about 10 per cent. of the salt itself. 19·98 grammes of hydrochloric acid added to 80·02 of water make sp. gr. 1·098, and is a 25 per cent. solution. This also was reduced to 1·093.

Experiment made of inverting a test tube containing one of these liquors into a pneumatic trough containing another. In each case pretty rapid mixture resulted.

The hydrochloric acid solution was then diluted with an equal volume of water, making its sp. gr. 1·030. A test tube was filled with this and inverted over the baric chloride solution. There was no visible mixture; the place where the two liquids meet remained quite sharp.

October 30th, 1885.—A tube of uniform cross section and ·41 centimetre internal diameter was taken and bent as shown in fig. 2. Its total length was 84·2 centimetres. This tube was marked No. I.

It was filled with hydrochloric acid solution, of specific gravity 1·030, slightly tinged with litmus.

Two vessels containing the 1·093 solution of Na_2SO_4 and $BaCl_2$ respectively were arranged with vertical sticks of electric light carbon as electrodes, and their levels as carefully adjusted as possible. The final adjustment was performed by a short siphon tube with a pinch-cock in the middle, and full of hydrochloric acid of sp. gr. 1·093 (see fig. 3). The experimental tube No. I. was then introduced very carefully at 14 hrs. 58 min. At 15 hrs. 2 min. the pinch-cock of the levelling tube was closed, and the current started, flowing from $BaCl_2$ vessel to Na_2SO_4 vessel. Current strength ·01 ampère.

October 31st.—Noon: ring beginning to form.

22 centims. from Na_2SO_4 end, and
62·2 „ „ $BaCl_2$ end.

November 2nd, 1885.—Another similar experiment with same tube. Levelling tube started at 11 hrs. 49 min. Experimental tube put in 11 hrs. 55 min. Levelling tube closed at 12 hrs. 2 min., and current started of strength ·01 ampère.

By November 3rd, at 9 hrs. 47 min., ring formed; and at 14 hrs. the current was stopped. Strength, ·007 ampère.

Solutions then tested and found all right; apparently a satisfactory experiment. Distance of ring

from Na_2SO_4 end 24·6;
„ $BaCl_2$ „ 59·6.

November 3rd.—Another experiment started with the same tube; fresh liquids still with density 1·093 for $BaCl_2$ and Na_2SO_4, the HCl (coloured with litmus) of density 1·030. Levelling tube put in at 14 hrs. 30 min.; experimental tube at 14 hrs. 34 min. Levelling tube closed and current started at 14 hrs. 36 min. Strength of current ·009.

On November 4th at 10 o'clock the ring was formed.

Distance from Na_2SO_4 end 31·8 centims.
„ „ $BaCl_2$ „ 52·4 „

November 4th.—Similar experiment, except that the tube is filled with an uncoloured solution of HCl of ordinary testing strength—that is, one centigramme molecule in 5 cc. Average current strength, ·009.

Distance of ring from Na_2SO_4 end 16·8 centims.
„ „ $BaCl_2$ „ 67·6 „

November 6th.—Another experiment with the ·01 HCl is 5 cc. Current strength, ·009.

Distance of ring from Na_2SO_4 end 16·4;
„ „ $BaCl_2$ „ 68·0.

November 7th.—A blank experiment arranged purposely with no current. Tube put in and levelling tube closed at 13 hrs. 35 min. *By November 16th there was no ring formed and no deposit anywhere in the tube.*

November 24th.—Two other similar tubes prepared, each of the same internal diameter—·41 centims.—but of lengths, No. II. 87 centims., No. III. 88·4 centims. The three tubes were then filled with the HCl solution (·01 in 5 cc.) and arranged with three pairs of vessels in multiple arc. The result was that, while the precipitate occurred in tube I. in about its usual position, in tubes II and III. it occurred quite at the end of the tube where it dipped into the Na_2SO_4 vessel, and accordingly most of it fell out of the tube.

December 1st.—Another experiment started; tubes I. and II. as before, but a layer of paraffin over the vessels of tube III., and a siphon levelling tube full of paraffin dipping into it and left open, as shown in fig. 4. The current strength decreased steadily from ·01 to ·005.

In tube II. the chief precipitate occurred again close to the Na_2SO_4 end.

In tube I. the distances were 16·5 centims. from Na SO_4 end.
67·8 „ Ba_2 Cl end.
In tube III. they were 20·2 „ Na_2SO_4 end.
68·3 „ Ba_2 Cl end.

Precipitates appeared on December 3.

December 3rd.—Paraffin levelling tubes now provided for both tubes II. and III. The ring formed well in all three now, and quite blocked the tube. The distances were :—

In tube I. 15 centims. from Na_2SO_4 end.
69 „ $Ba\,Cl_2$.
In tube II. 21 „ Na_2SO_4 end.
66·4 „ $Ba\,Cl_2$ end.
In tube III. 21·5 „ Na_2SO_4 end.
66·7 „ $Ba\,Cl_2$.

Current strength in each tube about ·01 ampère.

December 5th.—Same experiment repeated with 22 cells, tube I. being the only one without paraffin. The distances were :—

	I.	II.	III.
From Na_2SO_4 end	16·1	22·2	22·2
From $Ba\,Cl_2$ end	67·6	64·8	66·1

Current strength about ·015.

December 5th.—The same experiment repeated, but with only 3 cells. By December 9th a ring had formed in II. and III., but not in I. Distances of ring :—

In tube II. 25·9 from Na_2SO_4 end.
60·9 „ $Ba\,Cl_2$ end.
In tube III. 27·1 „ Na_2SO_4 end.
60·9 „ $Ba\,Cl_2$ end.

Current strength in each tube about ·002 ampère.

Experiments with tubes of different bore.

Two fresh tubes were prepared, Nos. IV. and V., of about the same length, but smaller in bore than the first three, No. IV. being about ·3 centim. diameter and No. 5 about ·22.

(For more accurate gauging of all the tubes see below.)

December 9th.—Two tubes, Nos. II. and V. arranged in series; two other tubes, Nos. III. and IV., also arranged in series, and the current from 16 secondary cells allowed to divide between the two pairs, starting at 4 p.m. on December 9th.

Current strength in tubes III. and IV. decreasing from ·0075 to ·0035; in tubes II. and V. from ·005 to ·0012.

By December 11th, 10 a.m., a ring was almost completely formed in tube IV., fairly so in V., an indication in III., and nothing in II. By December 12th a ring formed in tube III., and by December 14th it was beginning also in tube II.

December 14th the state of the tubes was sketched thus :—

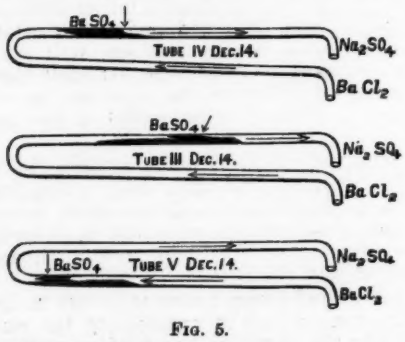


FIG. 5.

On the 15th the state of tube II. was this —

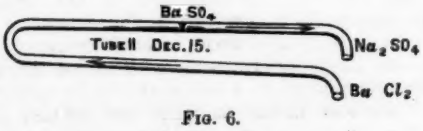


FIG. 6.

An arrow marks the place of first appearance of the ring. The distances are as follows :—

	II.	III.	IV.	V.
Distance from Na_2SO_4 end	19·0	17·5	30·5	45·8
„ „ $Ba\,Cl_2$ end	66·7	69·5	54·7	40·7

December 15th, 7 p.m.—Vessels same as in last experiment, but tubes arranged II. and IV. in series, one pair, and III. and V. in series the other pair.

Current strength in II. and IV. from ·0095 to ·0044; and in III. and V. from ·0062 to ·0022.

By December 16th, 4 p.m., deposit showing itself in tube IV.

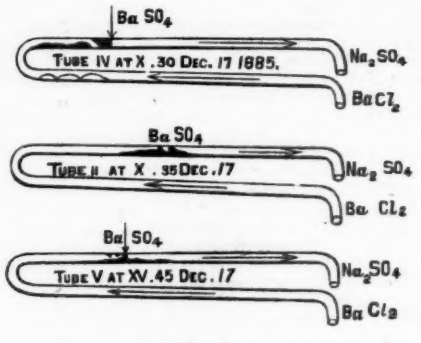


FIG. 7.

December 17th, 10 a.m., ring formed in tube IV., and almost complete in II. An indication in V. By 3 p.m. the ring in V. was complete, and a slight deposit in tube III.

On December 20th ring complete in III., and current stopped. Distances of ring when first formed :—

In tube	II.	III.	IV.	V.
From Na_2SO_4 end	21·5	17·1	28·6	24·3
„ $Ba\,Cl_2$ end	64·5	69·8	56·4	62·2

Gauging of the Tubes.

January 6th, 1886.—Determined bore of tube by filling them with mercury at 12° C.

——	I.	II.	III.	IV.	V.
Length in centims	82·5	85·7	87·3	85·4	86·3
Weight of mercury filling tube, in grammes	157·0	161·3	157·92	113·4	56·65
Calculated volume	11·6	2·0	11·7	8·4	4·2
Sectional area...	·14	·14	·134	·0983	·0487
Diameter of bore	·423	·423	·404	·355	·25

January 7th.—Experiment with all four tubes in multiple arc, two of them dipping into the same pair of vessels; the solutions of $Ba_2\,Cl_2$ and Na_2SO_4, weaker than before. viz., sp. gr. 1·050, because in the cold weather the sulphate of soda was apt to crystallise out of the old solutions. Current started at 5 p.m., 20 cells. By January 9th, 9 a.m., rings were formed in tubes II., III., and IV. No ring in V., but some air bubbles had collected in it, and apparently stopped its current. The rings in II. and IV. were beautifully sharp.

	II.	III.	IV.
Distance of ring from Na_2SO_4 end	17·0	6·5	16·9
	68·7	80·8	68·5

January 9th.—Another similar experiment, but with 15 cells. By the morning of January 11th rings were formed in 3 tubes, and one was forming in tube V.

	II.	III.	IV.	V.
Distance from Na_2SO_4 end	26·5	10·4	21·0	33·7
„ $Ba\,Cl_2$ end	59·2	76·9	64·4	52·6

January 22nd.—A precisely similar experiment, except that 20 cells were applied. By January 23rd (evening) rings were forming in three of the tubes, but there was an air bubble again in V.

	II.	III.	IV.
Distance of ring from Na_2SO_4 end	34·3	22·3	24·4
„ „ $Ba\,Cl_2$ end	51·4	65·0	61·0

February 1st.—Similar experiment.

	II.	III.	IV.	V.
Distance from Na_2SO_4 end	38·2	30·6	26·2	23·1
„ „ $Ba\,Cl_2$ end	47·5	56·7	59·2	63 2

So far the data are not satisfactory. There is a decided concensus in favour of the more rapid travelling of Ba than of SO_4, but no estimate of the ratio of the velocities can be relied on. The average makes Ba travel 3·2 times as fast as SO_4.

Experiments on jelly-filled tubes.

Four new tubes were made of dimensions and numbers here specified :—

Number	VI.	VII.	VIII.	IX.
Length	86·6	88·3	84·8	103·8 centims.
Diameter	·327	·460	·476	·825 ,,

A gelatine solution was made by dissolving 20 grammes of gelatine in 150 cc. of dilute acetic acid of ordinary testing strength, viz., 1 centigramme molecule per 5 cc., the tubes filled and allowed to go solid. The tubes were arranged in multiple arc with a galvanometer able to be switched at pleasure into the circuit of each. The solutions in the vessels were Ba Cl_2 and Na_2 SO_4, as before.

February 13th.—The E.M.F. of 24 cells was applied to these four new tubes at noon, and readings of the current (which was very weak) taken at intervals.

It was found that something in travelling from the anode vessel (presumably the Ba) rendered the jelly turbid, and that the turbidity, being sharply defined, served as an indication of the distance to which this ion had reached. Marks were accordingly made on the tube to fix its position at different times, the distances of these marks from the end of the tube being afterwards measured. After a time the SO_4, travelling from the other end, met the Ba and precipitated a sharp ring of Ba SO_4, whose position was noted. The current was not stopped, however; it was left on to see at what rate the precipitation advanced, and whether it advanced in both directions or in only one. In the free liquid HCl tubes it had seemed only to advance in the direction opposed to the current, viz., towards the Ba Cl_2 vessel. It was now observed in these jelly tubes to widen out both ways, but faster towards the Ba Cl_2 vessel than towards the Na_2 SO_4.

It was specially noticeable that in these jelly tubes the disc of Ba SO_4, indicating the meeting of the ions, was formed near the middle of the tube, instead of much nearer the Na_2 SO_4 end, as it had done in free liquid. Thus while Ba travelled 41·1 cm. to the meeting place, SO_4 travelled 45·5, in tube No. VI. In the tube No. IX. Ba travels 47·8, while SO_4 travels 56·6, and so on; see following table.

SUMMARY OF EXPERIMENTS ON TRAVELLING OF BA THROUGH FOUR JELLY TUBES.

Date.		Tube VI.		Tube VII.		Tube VIII.		Tube IX.	
Day.	H. M.	Distance travelled by Ba.	Current milli-ampères.	Distance travelled by Ba.	Current milli-ampères.	Distance travelled by Ba.	Current milli-ampères.	Distance travelled by Ba.	Current milli-ampères.
Feb. 13	12 0	started	·12	started	·18	started	·22	started	·54
14	14 0	...	·12	...	·21	...	·25	...	·56
15	12 3	6·9	·12	6·5	·24	7·1	·28	5·9	·76
15	16 15	7·88	·14	7·41	·32	8·1	·39	6·7	·83
15	20 15	8·75	·12	8·25	·21	8·95	·25	7·3	·61
16	10 10	11·12	·12	10·12	·21	11·33	·25	8·92	·61
16	19 10	12·75	·14	12·95	·24	12·95	·28	10·2	·64
17	11 10	15·45	·11	14·55	·21	15·65	·23	12·1	·46
18	10 10	19·15	·16	18·02	·26	19·32	·30	14·8	·75
18	18 10	21·08	·17	19·9	·26	21·25	·33	16·12	·82
19	10 10	23·98	·10	22·7	·17	24·2	·21	18·3	·49
19	21 28	25·6	·09	24·25	·16	25·93	·17	19·5	...
20	10 10	27·2	·09	25·85	·16	27·6	·20	20·8	...
20	20 15	...	·16	27·45	·20	29·32	·23	22·0	...
21	9 45	30·55	·11	29·2	·18	31·2	·20	23·43	...
22	10 15	33·68	·12	32·55	·18	34·5	·24	25·8	...
23	10 10	37·05	·10	35·72	·16	38·15	·18	28·45	...
24	10 10	39·72	·09	38·5	·16	40·6	·18	30·5	...
25	10 10	41·1	·11	40·85	·16	41·22	·18	32·6	...
		Ba SO_4 forming	disc			Ba SO_4 formed	disc		
				Ba SO_4 forming	disc				
25	21 15	...	·09	41·3	·14	...	·16	33·7	...
26	10 10	41·4	·09	...	·15	41·5	·17	34·8	...
27	12 12	...	·08	...	·17	...	·18	37·5	...
				current	stop	ped			
...	...	...	...	...	...	{42·92 / 35·4}	·13	40·9	...
*Mar. 4	10 10	{42·65 / 36·2}	·07	...	...	...	·15	46·5	...
		current	stop	ped					
4	23 57	...	...	...	...	{43·16 / 34·6}	·17	47·82	...
5	10 10	...	...	...	...	...	·13	Ba SO_4 disc just forming. Disc 2 mms. wide current stopped.	

* The 3 pairs of bracketed numbers about this date relate to the two ends of the plug of precipitated Ba SO_4, and show the rate at which this plug grew in thickness.

Lighting Tenders Wanted.—The Goole Local Board invites tenders, to be sent to Mr. G. England, clerk, by September 1st, for the lighting of the town by gas or otherwise.

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 181.)

DYNAMOS AND MOTORS—(*continued*).

THE efficiency of dynamos and motors used till lately to be tested by means of dynamometers and brakes. To test a dynamo its power was supplied through a transmission dynamometer, and the out-put was measured by suitable instruments, and the gross efficiency was thus obtained. The drawback to such methods is that few people have dynamometers, and the loss in the conversion of the mechanical into electrical power is too small to be measured by such means; in fact, the errors arising in the dynamometer might easily be greater than the whole loss in conversion.

Such rough methods have been superseded by more simple, and at the same time more scientific means.

Dr. Hopkinson's method is well known, as it has been frequently described. He couples a dynamo and motor together rigidly so that one can turn the other. The motor drives the dynamo through the rigid coupling, and the dynamo gives back most of the power electrically to the motor. The loss in the two machines is supplied by a small belt with a transmission dynamometer. As the power supplied to the system by the belt is only a small fraction of the whole power to be measured, any slight inaccuracy arising from the use of the transmission dynamometer is insignificant in comparison with the power transmitted through the motor shaft. The electrical measurements are, of course, capable of great accuracy.

Shortly after the publication of the tests of the Edison-Hopkinson machines by Dr. Hopkinson's method, the writer discussed with Mr. Crompton several methods of coupling up machines wound in different manners, so that the lost power could be supplied electrically instead of mechanically. This method was brought before the Dynamicables, or mentioned there by Mr. Crompton. Lord Rayleigh almost immediately afterwards proposed in this journal to supply the power electrically instead of mechanically.

The publication of the Manchester tests also brought out the information that Captain Cardew used to use a method of testing in which all the measurements are electrical. The dynamo supplies electrical power to a motor, and this power is measured by suitable instruments. The motor then drives a dynamo, and the output of the dynamo is measured. From these data the efficiency of the machines can be calculated.

Various modifications have been proposed, differing chiefly in detail. The drawback to Hopkinson's method is that it is not applicable unless there are two similar machines to be tested, and this is seldom the case; moreover, it would not do well for small machines. Captain Cardew's also demands three machines, of which two must be adaptable as dynamo and motor, and must be large enough to run the other at full load.

The writer has brought out a system in which, besides the machine to be tested, only a comparatively small dynamo is necessary. This system is so much simpler and so much more generally convenient, that it will be fully described without further discussion of the other methods.

There are several distinct sources of loss in dynamos and motors, namely, loss in overcoming the resistance of the wire on the armature and field magnets, loss in mechanical friction in the bearings and against the air, loss by reversal of magnetisation of the armature core, and loss by eddy currents in the armature core, and in the armature conductors in large machines, and in some cases in the field magnets. The loss by resistance of the conductors in a machine can be calculated, and the whole loss in the machine can be also determined; the difference between these gives the loss by

friction and by eddy currents and reversal of magnetisation, but as these losses cannot well be separated they may be all treated together and called the stray power.

The stray power is determined by exciting the field magnets so that the armature has the same induction as at full load, the electromotive force on it being such that it goes at its normal speed. The power taken to drive it is equal to the stray power at full load.

Take, as an example a shunt-wound dynamo, giving 100 volts and 500 ampères at 950 revolutions per minute. Suppose the shunt resistance is 12 ohms and the armature resistance is ·006. The armature loss is then the square of the armature current multiplied by the resistance, or $(508)^2 \times \cdot006 = 1{,}548$ watts. The loss in the field is $100 \times 100 \div 12 = 833$. To determine the stray power it is necessary to find the armature electromotive force at full load. As the resistance is ·006 and the current 508 ampères, the loss is 3; so that the armature electromotive force is 103 volts. The little dynamo must, therefore, be arranged to give 103 volts, and the dynamo to be tested must be run as a motor by it. It will, of course, run at less than 950 revolutions, as the field will be over excited, and there will be no back induction. Resistance is then inserted in the shunt circuit till the speed reaches 950. The electromotive force and current through the armature are then measured, and their product is the stray power. Suppose, for example, that the readings are 103 volts and 9 ampères, the stray power is then 927 watts.

By back induction the writer means the negative induction due to the armature wire, which opposes the induction due to the field circuits, that is to say, the effect of the current in the armature wires included in twice the angle of lead of the brushes.

It is, perhaps hardly necessary to say that induction is used in more than one sense, and that back induction has nothing to do with self-induction. There is a popular error to the effect that self-induction is in some way or other a source of loss of power in a dynamo. There is no loss of power by self-induction; from the nature of self induction such a thing is unthinkable. Self-induction can no more cause a loss of power, or a back electromotive force, than a fly-wheel can absorb power in an engine.

Taking the loss as 1,548 in the armature, 833 in the fields, and 927 stray power and 50,000 as the output, we get the total power supplied by the belt = 53,308, so the gross efficiency is 50,000 53,308 = 93·8 per cent. As a dynamo, the electrical efficiency is 50,000 52,381 = 95·5 per cent., and the efficiency of conversion is 52,381 53,308 = 98·3.

To find the efficiency as a motor, we must find what the machine will do as a motor. It may be run with 100 volts on the terminals, in which case it will not run at 950 revolutions, because with 100 volts on the field that gives 103 armature volts, which would take 106 terminal volts. It would therefore run at 895 revolutions with 100 terminal volts. We may, however, assume the same speed, but imagine the shunt wound so as to give the same ampère turns with 106 volts, in which case its resistance and the electromotive force on it are both higher, but the power absorbed is sensibly the same, namely, 833 watts. We then have also the same loss in the armature, as the armature current will remain 508 ampères, the armature having had that current before. The stray power also remains the same, namely, 927 watts. The motor thus receives $106 \times 508 = 53{,}848$ watts supplied to the armature and 833 to the fields, making 54,781. Of the power given to the armature, the power equal to the product of the current and back electromotive force, viz., $103 \times 508 = 52{,}324$ watts, is converted into mechanical power. Of this 927 is lost as stray power, so 51,397 watts are available on the pulley of the motor.

The conditions as a motor are then 106 volts, 516 ampères, as the shunt still takes practically 8 ampères. The electrical efficiency = 52,324 54,781 = 95·7 per cent., the gross efficiency is 51,397 54,781 = 93·7 per cent., and the efficiency of conversion is 51,397 52,324 = 98 per cent. The differences between the efficiencies as a motor and as a dynamo are due merely to the way of taking them. The differences are small in this case because a machine of high efficiency has been taken, but in the case of a small machine the difference would be greater; just as the difference between discount and premium increases with the percentage.

If the machine is compound or series wound, of course it is equally easy to test the machine. A series wound machine must of course be separately excited for the determination of the stray power.

Compound motors need not be considered, as there is no use in winding such things. The shunt motor if properly designed, and properly wound, runs at practically constant speed, not only with varying load, but with varying electromotive force on the terminals.

The efficiency of conversion really depends very much on the oil used, and is never a fixed quantity that can be accurately determined.

Of course, the efficiency, as well as the output, is not a property inherent in a machine. People often talk of such and such a machine as having an efficiency of 90 per cent., and an output of so many watts, but such expressions are to a great extent meaningless.

A great deal of harm is done by the growing custom of making slow speed dynamos. In some cases saving space is so important a consideration that it overrides any objection there may be to direct driving, but in most cases slow speed dynamos are a great mistake. A machine which will at 1,200 revolutions give 50,000 watts with an electrical efficiency of 94 per cent. loses 5,320 watts. If it is run at 400 revolutions its output is 55,320 3 — 5,320 = 13,120 watts only; and its efficiency will be only 71 per cent. A slow speed machine for a given output is therefore not only larger, but even then has a low efficiency. The loss by using a slow speed machine is very much greater than that of an intermediate shaft, and the first cost is also very much greater. It is just as absurd to run a slow speed dynamo as it would be to run a steam engine or gas engine at a third of its normal velocity.

(*To be continued.*)

NOTES.

Boat Lighting by Electricity.—One of the "sights" at Datchet Regatta, on Saturday last, was a punt lighted by five Bernstein lamps fed by six Tatham storage cells. Mr. Mackenzie had the cells brought down in the afternoon fully charged, and placed them in his small craft, which during the evening formed quite a noticeable object on the river in the midst of the other boats, many of which were beautifully decorated with lanterns, as each lamp gave a light of about 45 candle-power, or altogether about 225. The lamps were connected in parallel, so the discharge from the cells was about 60 ampères. Each cell weighed only 75 lbs., and the battery proved sufficient to keep the lights going without any appreciable fall for about three hours.

Electric Lighting in Madrid.—The electric light is making good progress in Madrid, although, as yet, there is no central station for public supply. On the other hand, private isolated installations are fairly frequent. Two large installations will shortly be given out to tender, states the correspondent of *Industries*. One is the prison, where upwards of 1,400 lights will be required, and where the present annual cost of lighting by gas amounts to £4,800. The other is the Royal Opera House, where a still greater number of lights will be required. In both cases a large saving is expected from the adoption of the electric light.

Electric Lighting of Theatres.—The *Figaro* states that from January 1st, 1888, the following Paris theatres will be illuminated by the electric light:—Opéra, Comédie-Française, Odéon, Vaudeville, Palais-Royal, Gymnase, Porte-Saint-Martin, Ambigu, Folies-Dramatiques, Nouveautés, Chatelet, and Variétés.

The Electric Light at the Vienna Opera.—The *Daily News* last Saturday gave a lengthy description of the lighting of the Vienna Opera House. The installation was opened on the previous Thursday and proved a great success, the audience warmly applauding. "Everybody found the cool and fresh air of the house very pleasant. The lighting of the stage excited much admiration. The actors seemed to stand out more boldly than formerly, and the effect of the scenery was greatly heightened." The generating station is placed in the Schenkenstrasse, a central point of the city, in the house formerly occupied by the British Embassy. In this building preparations in the shape of foundations have been made for machinery sufficient to supply 20,000 lamps, but that already fixed is sufficient for the Opera House and the Burg Theatre, which together take from 9,000 to 10,000 lamps. The boilers, engines and dynamos and all the heavy machinery were supplied and fixed by Messrs. Crompton & Co., of Chelmsford. The engines were of the Willans high-speed compound type. The total horse-power of the plant already fixed is about 700. Four cables have been laid underground from the Schenkenstrasse to the Opera, a distance of about three-quarters of a mile. They are distributed to the various sets of accumulators (which were supplied by the Electrical Power Storage Company) by four large commutating apparatus, which are said to be the largest ever made. Thence cables lead to a room near the stage, from which branches extend to every part of the house. In the auditorium nearly all the lights have been placed in the original gas fittings. The introduction of the light is due to the Emperor of Austria, who, after the burning of the Ring Theatre, determined to remove one source of danger by insisting that in future all large theatres should be electrically lighted. He gave orders to that effect to the managers of those theatres which are immediately under Court control, and contracts were entered into with the Imperial Continental Gas Association for lighting the Opera and the Imperial Burg Theatre. There were difficulties with the municipal authorities, but these were overcome, and the installation was completed. The same system, it is stated, is to be applied to all the theatres, public buildings and large palaces in central Vienna.

Electric Lighting at Berlin.—The difficulties between the town authorities and the Electric Light Works do not as yet seem any nearer to a settlement, reports the Berlin correspondent of *Industries*. There is a want of agreement about certain details regarding street lighting, and the new Kaiser Wilhelmstrasse will in consequence not be lit by electric lamps, but by Siemens's regenerative gas burners. The Town Council are proposing to light the streets by water power derived from the river Spree; but as this power is very variable, and at best only limited in amount, there is not much to be urged in favour of this scheme. Messrs. Siemens & Halske are now busy with thirteen dynamo machines of their new type, each for an output of 100 kilo-watts. These machines are intended for the lighting of the railway station in Frankfort-on-the-Main. Each machine will be driven direct from a water engine made by Messrs. C. Hoppe & Co. under their new patent. The speed will be 150 revolutions per minute, and the engines will work with a pressure of 1,100 lbs. per square inch, the water being taken from the general system of hydraulic mains used for working capstans, cranes, and travelling platforms in the station.

The Electric Light in Libraries.—It is enough, says the *Journal of Gas Lighting*, to make gas engineers rub their eyes to read in the *Revue International de l'Electricité* the observations of Prof. Wiesner, of Vienna, upon an inconvenience attending the use of the electric light in libraries. It had been discovered that a large number of works in the library of the Technical School at Vienna had become very yellow, and accordingly the director of the establishment requested Prof. Wiesner to discover the cause of this phenomenon. Experiment showed that the coloration was due to light, but that it occurred only with paper containing ligneous substances such as wood, straw, and jute, and did not take place when, through chemical action, the lignine of the wood was removed. The yellowing effect was due to oxidation of the lignine, which can only occur in light. Sunlight is very active in causing this oxidation; but the effect of diffused daylight, especially in a dry room, is very slight. Gaslight is nearly harmless by reason of the few refrangible rays that it contains; but, on the contrary, the electric light strongly favours the yellowing. With a view to the preservation of papers, therefore, Prof. Weisner concludes that gas is preferable to the electric light for libraries. This is indeed a turning of the tables.

Electric Lighting of a Distillery.—Messrs. R. W. Preston & Co., the well-known firm of distillers, have adopted the electric light for their extensive premises at Bankhall, Liverpool. The installation has been designed and successfully carried out under the superintendence of Mr. T. M. Bigley, C.E., Liverpool.

Fire Alarms by Telephone.—The Local Board of Gosport have recently been perplexed at the difficulty of communicating speedily, in case of an outbreak of fire, with the waterworks' pumping station which is situated about two miles from the town. On a recent occasion considerable danger was encountered on account of the paucity of the water supply, and to avoid the recurrence of anything of the kind in future it has now been decided to fix a telephone between the fire-engine house and the pumping station, at a cost of £40. This is the first official recognition in Gosport of the utility of telephonic communication, and a start having been made the Local Board may before long follow the example of their neighbours on the other side of Portsmouth Harbour and connect by wire the whole of the public offices.

Telephones in America.—The American Bell Telephone Company has lately published some details as to its operations in the United States up to January 1st, 1887. The following figures are given:—

	1885.	1886.	1887.
Number of systems	736	747	773
„ „ circuits	107,440	112,067	121,260
Miles of conductor	101,734	114,046	128,231
Number of employés... ...	5,168	5,438	5,843
„ „ subscribers ...	134,847	137,750	147,068

Repairing Atlantic Cables.—We understand that the *Faraday* and the *Mackay-Bennett* are about to repair the broken down Jay Gould Atlantic cable. In view of what occurred on a previous repair to one of the Atlantic cables, we should not be surprised to learn that some of the other Atlantic cable companies were also putting in commission one or more repairing ships.

City and Guilds of London Technological Examinations.—At the last examinations we observe that the first and second places (with first class honours, £5 each, and the silver and bronze medals), in electric lighting and transmission of power have been taken by G. L. F. Phillips and Charles Yeaman, both students of Prof. Jamieson's at the Glasgow College of Science and Arts.

New Electrical Paper.—A favourable period for starting an electrical paper in Boston, Mass., was chosen by the promoters of *Practical Electricity*, when they decided to present their offspring to the world in the month of August, for it was just in time to make itself known to the host of people connected with the electrical profession gathered at the great intellectual centre for the semi-annual convention of the National Electric Light Association. The new paper is a monthly one, and the first number deals in an able manner with a wide range of interesting subjects. We wish it every success.

Lightning Conductors.—The question of thunderstorms and the best means of protection against lightning has for some time engaged the attention of the Berlin Society of Electricians, which instituted a committee to investigate the cause of thunderstorms and earth currents. A very full report, giving instructions for the erection of lightning conductors, was issued by the committee about 15 months ago, and the Municipality of Berlin, *Industries* states, has at last taken steps to have all public buildings protected in accordance with these instructions. The earth circuit from the lightning rods must in all cases consist of a copper cable not less than ·4 inch in diameter, and in addition to this every lightning rod must be provided with a testing circuit and switch reaching close to the ground, but thoroughly insulated from the building and from earth. This addition has been adopted in order to facilitate the testing of the lightning conductor without the necessity of mounting on the roof of the house. With a view to a closer study of the phenomena of thunderstorms, observatories for lightning are being erected on the Schneekoppe, in the Riesengebirge, Upper Silesia. Each station is provided with two lightning rods fixed on the top of iron masts 53 feet high, which are thoroughly insulated from earth, the iron masts being attached to a strong timber frame work resting on large glass insulators, which are placed in lead vessels filled with sulphuric acid. Contact with earth can be made by switches, if desired. Points of platinum, gold, and carbon in various shapes will be experimented upon.

New Professor of Physics at Cornell.—Professor E. L. Nichols, of the University of Kansas, has been appointed to the chair of Physics at Cornell University, in place of Prof. Anthony, who has resigned. The *Ithaca Journal* says :—"Professor Nichols graduated at Cornell University with high honours in 1875. He had already acquired an especial taste for physics, and, accordingly, immediately after receiving his degree, he went to Germany, where, during four years, he prosecuted his studies mainly in the laboratories of Helmholtz and Kirchoff in the University of Berlin. After taking the degree of Ph. D., he returned to America, and for one year held a fellowship in Johns Hopkins University. He then had a year of experience in the further study of electrical physics in the laboratory of Edison at Menlo Park. In 1882 he entered upon the practical work of a professor of physics, and has been so successful in building up the department at the University of Kansas that the University, during the past winter, made a special appropriation of $5,000 dollars for an electrical equipment. The testimony is unanimous that Professor Nichols is a brilliant experimenter and an excellent lecturer. While he is a very industrious worker in the laboratory, he has good social qualities, as well as the invaluable characteristic of ambition and good health. During the past five years he has published numerous papers read before the American Association, and may confidently be relied upon to keep the work of the laboratory here prominently before the scientific world."

The Telephone in Australia.—The Government of New South Wales has for some time past utilised the telephone as a means of communication between outlying districts, where telegraphic business is not sufficient to engage the whole attention of an operator. The innovation has worked so well that at the present time there are no less than 40 telephone stations in New South Wales. In only two instances, however, has the postal department of Victoria employed the telephone in this manner, and even in these cases it has only been with the object of permitting communication to be maintained with the lighthouse keepers at Point Lonsdale and Cape Nelson. The example of New South Wales, however, is likely to be followed in the future, as several deputations have been promised telephonic communication with stations which cannot now be reached by telegrams.

Military Experiments with the Search Light.—Some important and interesting experiments were last week made at Lydd camp. Captain Hawkins, R.E., demonstrated the usefulness of a new and ingenious method of working electric search lights. The object was to work the search lights under the fire of the rifles and Gardner guns of an enemy. The engine and apparatus which worked the light were placed under a casemate about 200 yards from where the light was actually seen. The light was so arranged as to be under cover, and to throw the rays on to a reflector on the top of a parapet by means of which the country all round was scoured under a shower of bullets fired at the reflector. The reflecting disc had a diameter of 26 inches, and it was found that, although it was struck by bullets several times, the damage to the reflector was practically nothing, the reflecting power being only diminshed by the area of a bullet hole. The reflector was worked by four temperary guy ropes, placed at equal distances round its surface, two to give depression or elevation, and the other two for lateral direction ; the whole of these movements, of course, being worked from the casemate. The difficulty in shooting at this bright light was found to be very great indeed, and aim can only be taken through a dark piece of oiled paper placed over the foresight. Ten marksmen of the East Surrey Regiment, under Lieutenant Birch, and a Gardner gun in charge of Lieutenant English, were brought to bear upon this light. Several hundred rounds were fired at a range of 1,000 yards, and a similar fusilade made at 600 yards. It was found after two hours' sharp firing that the reflector had been struck 15 times without being seriously damaged. The light was shown at intervals of about a minute only. At a former experiment it was found that under similar conditions the reflector was only struck four times, and by the Gardner gun only.

A Long-Lived Edison Lamp.—In the office of the sub-editor of this journal, says the *Toronto Globe*, is a 32 candle-power Edison lamp which has been burning full power five hours every night, six nights a week, ever since the installation of the system in November, 1884. The lamp was guaranteed for 600 hours, but is still burning with undiminished power after more than 4,700 hours' service.

Execution by Electricity.—An electrician of New York—at present a visitor in the French capital—recommends to the attention of sensitive Frenchmen three systems for putting condemned criminals to death, which are, he says, being studied in his own country, and one of which, he believes, will shortly be selected for carrying out the death sentence. The first consists of a copper bandage placed round the criminal's head in such a mannner that a magnetic pole presses closely on the nape of the neck. The "patient" stands on a large zinc platform, his hands being tied behind his back. A second pole is attached to this species of platform, and at the right moment the signal is given, the discharge takes place, death being instantaneous. M. Jablochkoff has invented a more "comfortable" plan, his notion being to place the condemned man in an easy chair, with his hands on the arms of the *fauteuil*, and his feet touching the zinc platform. A stop is pressed, the electric current "seizes the man by the two elbows and by his feet," and in half a second all is over. A third system has been devised by another electrician which differs in no material way from the first mentioned ; and certain American legislators are, it appears, carefully examining the three with the object of deciding in favour of that which will ensure the quickest and most painless death.

The Liverpool Tramways.—The Health Committee of the Liverpool Corporation has decided to make a recommendation to the Council to obtain further powers to use steam or other mechanical power on the tram lines constructed under the Acts of 1868 and 1871.

Whitworth Scholars for 1887.—From the list of Whitworth scholars for 1887, which was issued lately, it appears that out of the twenty-one scholarships, seven have been gained by Scotch students, and of these five—the second, fourth, sixth, seventh, and ninth—have been carried off by students of the Glasgow College of Science and Arts. J. Calder is second; N. K. Turnbull, fourth; A. F. Horne, sixth; E. J. Duff, seventh; and W. Thomson, ninth; and all of them take scholarships of the value of £150. E. Griffith, Anderson's College, Glasgow, is eleventh, and receives a scholarship of £100, and D. Young, Edinburgh, who is twentieth, takes one of the same value. The Glasgow College of Science and Arts students has secured seventeen Whitworths, of a total value of £2,300, at the last four competitions. We may mention that Prof. Andrew Jamieson has been for the last seven years, principal of this technical college, which is now merged, with Anderson's College and Allan Glen's, into the Glasgow and West of Scotland Technical College. The following is the complete list:—1, J. Whitaker, Burnley, £200; 2, J. Calder, College of Science and Arts, Glasgow, £150; 3, J. Smith, Belfast, £150; 4, N. K. Turnbull, College of Science and Arts, Glasgow, £150; 5, J. C. Talbot, Southampton, £150; 6, A. F. Horne, College of Science and Arts, Glasgow, £150; 7, E. J. Duff, College of Science and Arts, Glasgow, £150; 8, R. N. Blackburn, Liverpool, £150; 9, W. Thomson, College of Science and Arts, Glasgow, £150; 10, W. F. Tullen, Cardiff, £100; 11, E. Griffith, Anderson's College, Glasgow, £100; 12, F. C. Tipler, Crewe, £100; 13, T. H. M. Bonell, Swindon, £100; 14, R. J. Bedding, Woolwich, £100; 15, A. W. Lisson, Lincoln, £100; 16, A. H. Abbott, Great Yarmouth, £100; 17, G. Hough, Wolverton, £100; 18, H. G. Christ, London, £100; 19, H. D. Griffiths, Cardiff, £100; 20, Young, Edinburgh, £100; 21, B. C. Oxford, Liverpool, £100; 22, B. H. Crookes, Liverpool, £100; 23, G. J. Wells, London, £100; 24, J. Eustace, Camborne, £100; 25, A. H. Bratt, Woolwich, £100.

Electro-Plating.—The returns for last month in this industry show a great falling off, and there is a scarcity of orders. Some of the Sheffield houses have been kept busy by the foreign trade, but the general trade is of a very moderate character.

Overhead Wires in New York.—The replacement of overhead wires by underground conductors, desirable though it be, does not proceed at a very fast rate, and the New York Board of Electrical Control, who are wise in their generation, says *Industries*' New York correspondent, prefer to regulate the overhead systems rather than demand their immediate removal, which is practically impossible. They met last month and issued a new set of rules, or, rather, a set of rules in addition to those already in force, with a view to at least mitigate the evil of overhead wires, since it was impossible to remove it altogether. Under these rules permission for the erection of poles and aerial lines will only be granted pending the providing of underground accommodation in the district, and no permission for an overhead wire will be granted if underground accommodation already exists or is in course of construction. No two lines of poles shall be on the same side of the street, and no two lines bearing wires for similar service shall be in any street. Under this regulation, therefore, telegraph and telephone wires may be on one side, and electric light or power wires on the other side of the street. Electric light poles must be at least 26 feet high, and telegraph or telephone poles 60 feet high. The wires must be fastened to wooden cross arms with glass, porcelain, or rubber insulators. No arc light or power wires must be stretched over any building. The companies or persons owning or controlling poles in any street or avenue shall allow the same to be used by other companies or persons operating conductors for similar electrical service when authorised so to do by the Board on tender of proper compensation, to be determined by agreement between the companies or persons interested.

Accident on the Blackpool Tramway.—On Monday afternoon an elderly man was crossing the road on the sea front at Blackpool, when he was knocked down by one of the electric cars and killed. The wheels went over his stomach, nearly cutting him in two. He was attended by a doctor, but died almost immediately. The deceased was an excursionist, and, according to the testimony of eye-witnesses, when he found himself in the path of the electric car he became bewildered. The driver, who had already switched off the current, leaned forward, and tried to push him aside, but did not succeed.

National Electric Light Association.—The semi-annual convention of the National Electric Light Association of America was held at the beginning of the month at the Parker House, Boston, and was well attended. There was an unusually large number of special exhibits, including electro-motors and power appliances, apparatus for arc and incandescent lighting, &c.

Fishing by the Electric Light.—Some interesting experiments in connection with the subject of fishing, the *Scotsman* states, have been carried on in the Firth of Forth, under the patent system of Captain Coppin. It has long been understood that fish are strongly attracted towards any bright light—a fact utilised by the salmon night-fisher, who uses a flaming pine-torch to bring the prey within reach of his "leister" or spear; and it is proposed under this system to employ by way of lure the powerful light of the electric lamp. A number of gentlemen having obtained the use of the steamship *Tweeddale*, kindly granted by Mr. Scott, of the General Steam Fishing Company, Granton, have had her completely fitted out for the purpose with electric apparatus, engine, and dynamo, arc lamps of 6,000 candle-power, incandescent submarine lamps, &c. The work has been done under the superintendence of Mr. Greville E. Johnston, on behalf of Messrs. T. H. Perry & Co., electrical engineers, Liverpool. Recently the vessel, thus equipped, was engaged in her novel fishing cruise in the neighbourhood of the Isle of May. The experiments, however, have not, so far, been successful. The electric lamps were sunk with the beam of the net to a depth of 40 or 50 fathoms, the glass globe being about $\frac{3}{8}$ of an inch thick. Operations were carried on for about an hour on two occasions, and it was found that the pressure of the water was too great for the strength of the glass, the result being that the lamps broke, and the light instantly went out. It is intended to renew the experiments, using stronger glass.

A Large Battery of Storage Cells.—The largest battery of accumulators now at work in France, says *Industries*, is that at the Hotel de Ville in Paris. It was installed on the recommendation of the late M. Bartet, of the Public Works Department, and according to the original intention it was to have sufficient capacity to keep the 2,200 Edison lamps in the Hotel de Ville alight during a whole night; but as actually installed it only acts as a regulating battery, and in case of accident to the machinery, would only suffice to keep the lamps going for an hour or two. This battery is remarkable for the fact that the old form of Planté cells with spiral plates has been chosen. The active surface of each plate is about 52 square feet, and the storage capacity has been increased on Planté's principle by pickling in nitric acid. Each cell is capable of giving a current of 240 ampères, which, at the average pressure of 1·9 volts, represents a discharge at the rate of ·6 H.P. Since there are 165 cells the total energy is about 100 H.P. These batteries were made by Reynier, and have a total weight of 11 tons. Current is supplied by three Gramme dynamos driven from portable engines in an annexed building, and since the speed of the engine is not very regular, the employment of these batteries as a steadying device has been found almost absolutely necessary.

Matronly Reserve.—During the thunderstorm the other day, several ladies who are no longer young were with their husbands on the road along which the Elieson locomotives run, but the utmost efforts of their lords, and the most persuasive eloquence of Mr. Elieson himself, were unavailing to induce them to enter the electrically drawn car, for they were quite positive that there must be a close relationship between the blaze-emitting clouds and the electric engine, and feared that there might be a mutual attraction between the two. Kyrie Eleison !

Telegraph Wires Broken.—On Tuesday morning a London and North-Western goods train from Rugby, on entering the Great Eastern Station, Peterborough, missed the points, and collided with one of the iron pillars supporting the roof. The pillar was broken in the middle, and a portion of the roof, about 60 feet by 40 feet, fell, breaking down the telegraph wires and doing other damage.

Scamped Telephonic Work.—A London correspondent states that last week's storm revealed a little scamped telephonic work in one of the suburbs. The lightning struck a wire connecting two surgeries of a doctor in large practice, and fused the instrument wires inside his house. On an examination being made, it was found that the workmen, instead of carrying the principal wire to the ground, had, to save trouble, placed it in the cistern, and, the water supply being restricted, the current produced the effect mentioned.

Memoir of Fleeming Jenkin.—Mr. R. L. Stevenson's biographical memoir of Fleeming Jenkin will (says the *Athenæum*) run, with appendices, to about one hundred and fifty pages. It will introduce the reader to a selection, in two volumes, of Mr. Jenkin's essays and reviews, arranged for publication by Mr. Sidney Colvin and Professor Ewing. The first volume will include a play in three acts on the story of Griselda, and various essays. The second volume, divided into three sections —"Political Economy," "Technical Education," and "Applied Science"—will contain a long article on trades' unions, a number of lectures and addresses, and essays on telpherage, submarine telegraphy, the application of graphic methods, and so forth. The volumes will be published some weeks hence by Messrs. Longman.

Secondary Generator Law Suits.—We understand that the law suit which has been going on in France between M. Gaulard and Messrs. Zipernowski and Déri has now been decided in favour of the former. A similar decision has also been given by the High Court of Berlin respecting the German patents. These results will probably have considerable influence upon the seconday generator patent question in this country.

Glasgow International Exhibition.—Arrangements are being made at Glasgow for the erection of a fairy fountain at the exhibition next year. The base is to be about 190 feet in diameter, with about 100 jets. The electric light in the chamber below the basin will be manipulated from a tower about 200 feet away, and a staff of men will be employed underneath the fountain to trim and attend to the electric lamps. The Exhibition buildings are making rapid progress, over 400 men being at work.

Overhead Wires.—The inconvenience and supposed dangers attendant upon an uncontrolled distribution of aerial wires, have brought about an agreement between the Municipal Council of the City of Mexico and the various electrical companies in that town. It has been arranged that the Municipal authorities will supply large posts, similar to those in use at New Orleans, and on which the wires of all the companies are to be suspended. Each company will pay the Municipality a yearly tax.

The Bradley Dynamo Machine.—Yet another design of dynamo is presented to us in the above machine, illustrated and described in the *New York Electrical World*. The description is written by the designer, who in the beginning leads off with a somewhat erroneous analogy between a dynamo and an induction coil, but at the finish arrives at the very sensible conclusion that the rectangle whose periphery is the shortest, and which still contains the greatest area, is a square, and that the machine, therefore, which, other things being equal, has a square armature core, gives the greatest E.M.F. with the shortest length of conductor. The armature of Mr. Bradley's machine is of the drum type with Pacinotti projections, the slots for the copper bar conductors being of great radial depth relatively to their width, and, in this respect, resembling the large "Phœnix" machines designed for France 18 months ago. The magnets are arranged so as to form a six-pole field, and disposed in a manner similar to those on the now almost-forgotten "Elphinstone-Vincent" machine. From the description, the method of winding and connecting up appears to be very similar, and we are much inclined to rename it an Elphinstone-Vincent, mechanically and electrically improved. However this may be, Mr. Bradley has produced a machine which gives a large output for its weight, although the efficiency is somewhat low. Here are some of the dimensions:—Armature core, $12\frac{3}{4}$ inches diameter by 6 inches wide, containing 153 lbs. of sheet-iron; 74 slots $1\frac{1}{16}$ inch deep, $\frac{192}{1000}$ inch wide at top, and $\frac{107}{1000}$ inch wide at bottom. Two bars are laid in each slot, which are insulated from each other and from the sides of the slots by mica, there being thus 148 conductors all round the circumference. The copper wire on the armature is 59 lbs. and on the magnets 108 lbs. At a speed of 582 revolutions the output is said to be 271·34 ampères at a difference of potential of 51 volts with an efficiency of 86 per cent. Since the total weight of machine is 1025·7 lbs., this is at the rate of 13·5 watts per lb. of material, or nearly 83 watts per pound of copper.

Secondary Batteries as Regulators.—From a paper by Messrs. Collins and Braddell in the *Electrical World* it would appear to be the opinion of these gentlemen that secondary batteries, when used in conjunction with a dynamo, will cause perfect steadiness in the lamps independently of the kind of machine employed. This is quite a delusion. Although the battery necessarily has a constant E.M.F., the difference of potential at its terminals varies with the variation in speed, and it becomes a question as to which is the best kind of dynamo to make the variation a minimum. As we have formerly shown, this is a shunt machine, with a rapidly falling characteristic.

Insulating Material.—Mr. Merritt, of Somerville, Massachusetts, has patented a new insulating material for conductors and electrical apparatus. It is made in the following proportions:—Two pounds of silicate of soda are mixed with water, to this is added a pound of tar; the composition is then heated and with it an amalgamated four pounds of powdered amianthus (silicate of magnesia), and one ounce of sugar. When these ingredients are thoroughly blended, about one-tenth of an ounce of nitric acid diluted in warm water is added. It is stated that this composition is flexible, easily applied, and fairly tough, but it possesses the disadvantage of being unable to resist high temperatures under which it speedily liquefies.

Gutta-Percha.—In a pamphlet issued by the London agents of the Berthoud-Borel Underground Electric Cable Company, it is stated, as an objection to the employment of gutta-percha, that this material "begins to liquefy and becomes useless above" a temperature of 30 centigrade = 86° Fah. This statement is somewhat misleading, since gutta-percha softens at 115° Fah., becomes plastic at 120° Fah., and melts at 212° Fah.

The Blackpool Tramway.—We are informed that the electric trams at Blackpool are now again in working order, and are running the whole distance of the line without the assistance of horse-power. The novelty has not worn off yet, and they have been better patronised this season than ever before.

Damage to Wires at Plymouth.—During the recent fire at the Eagle Joinery Works, Plymouth, considerable damage was done to the postal telegraph and telephonic wires which passed over the principal building attacked. As the flames burst through the roof the wires soon became hot and afterwards fell, switching several of the vast crowd which had assembled to witness the conflagration. A large staff representing the telegraph department was present and rendered such yeoman service that the falling telegraph poles, wires, standards, and other impedimenta were cleared away with surprising rapidity and did not interfere with the work of the fire brigade. The wires were fortunately purely local. The Telephone Company suffered more severely, as 14 or 15 wires passing over the building were all broken by the heat. At considerable risk to himself, Mr. Dawe, foreman to the company, entered the premises soon after the fire was discovered and brought out the telephone uninjured. The wires were cut away as soon as they fell. About 17 subscribers were temporarily disconnected, but the repairs were executed with great promptitude.

An Electric Circuit Tester.—Mr. W. J. Hammer, manager of the Boston Edison lighting station has devised a portable instrument for indicating the direction of flow of a current. It consists of an ebonite block provided with a handle; within the block are placed two reels for winding and unwinding a long strip of bibulous paper saturated with a solution of one of the cyanides of potassium, which may be made more sensitive by the addition of a little chloride of lime, or common salt. The strip of paper connecting the two reels passes over a metallic button which is connected to the binding post at the front end of the apparatus. Suspended above the button is a small iron stamp marked with an arrow in the centre of a circle, across which is printed the word "positive." This iron stamp is attached to the end of a spring and surmounted by an ebonite button, the other end of the spring being electrically connected with a binding post at the opposite end of the apparatus. To these two binding posts are attached two flexible wires which may be attached to the circuit to be tested. If the direction of flow of the current is from the binding post at the rear end of the spring, by striking the ebonite button a slight blow, so that the stamp is brought in contact with the paper, a circle containing an arrow pointing in that direction with the word "positive" printed across it will be printed thereon in dark blue, indicating that the terminal referred to is positive, and that the tendency of flow, so to speak, is from that direction. Should there be no mark made upon the upper surface of the paper, this would prove that it is the negative pole of the conductor.

The Telephone in Austria.—The Austrian Government is at last taking steps to introduce telephonic service between some of the smaller towns in the provinces, reports the Vienna correspondent of *Industries*. The first experiment, which was due to the initiative of Herr Pino, one of the Ministry, and which took place on a line from Vienna to Brünn, has been sufficiently successful to warrant the introduction of long distance telephony on a somewhat wider scale, and lines are now being erected between Reichenau, Baden, Wiener-Neustadt, Vöslau, Mödling, and Vienna. There is also telephonic communication with the Schneeberg, the Grossglockner, and other mountain stations in the Alps; whilst next year Salzburg, Cracow, Klagenfurt, and other towns will receive a telephone service under State management. The telephone system of Reichenau is at present connected with six public call offices in the environs of the town,

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

West African Telegraph Company, Limited.—At an extraordinary general meeting of this company held on the 20th ult. at 98, Cannon Street, the following special resolutions were passed, viz.:—"1. That section 81 of the Articles of Association be altered by striking out the word 'five' and inserting in lieu thereof the word 'three.' 2. That section 91 of the said Articles of Association be altered by striking out '£2,000' and inserting in lieu thereof '£1,200.'" The first of these relates to the minimum number of directors, and the second to the remuneration of the board. The resolutions were confirmed on the 8th inst., and duly filed on the 13th inst.

H. C. Bull and Company, Limited.—An agreement, dated 25th June, provides for the purchase by this company of a certain invention, apparatus, and premises, referred to an agreement of even date, and as consideration will issue to Mr. Wm. E. Lendey, of 2, Waterloo Villas, New Brighton, Cheshire, 40,000 full paid-up shares of £10 each.

Electrified Rooms Company (Capt. Arthur H. Byng's Patent), Limited.—At an extraordinary meeting of this company, duly convened by the liquidator thereof, and held at the offices of the Electrified Rooms Company, Limited, 24, Landport Terrace, Southsea, on the 9th inst., the accounts of the said liquidator were laid before the meeting, showing the manner in which the winding up has been conducted and the property of the company disposed of. These accounts were duly approved and passed, and the affairs of the company deemed to be fully wound up. The resolutions were filed on the 17th inst.

Hermite British Electro-Bleaching Company Limited.—The statutory return of this company, made up to the 10th inst. was filed on the 17th inst. The nominal capital is £50,000, divided into 1,500 "A" of £30 each, and 1,000 "B" shares of £5 each. 1,000 "A" shares are allotted, and are considered as fully paid. 751 shares have been taken up and the full amount has been called and paid thereon. Registered office, 13, Pownall Road, Dalston.

Domestic Battery Syndicate. Limited.—The registered office of this company is situate at No. 9, Gracechurch Street, E.C.

London Battery Company, Limited.—The registered office of this company is now situate at 132, Southwark Street, S.E.

CITY NOTES.

The Lancashire and Cheshire Telephonic Exchange Company, Limited.

THE report of the directors for the year ending June 30th states that the subscriptions and rentals (including those of the out-districts) amounted to £82,490 as compared with £72,508, the amount of income carried forward to next year's revenue, as representing sums received in advance for periods extending beyond June 30th, 1887, being £38,276 against £34,681. On the year's working the profit was £28,049. After deducting bank interest, interest on reserve fund, and the interim dividend paid in February, there is a balance of £14,212, and the directors recommend a further dividend at the same rate as in February, making a complete dividend of 7 per cent. for the year, £1,656 being carried forward.

United Telephone Company of the River Plate, Limited (*In Liquidation*).—The creditors of this company are required on or before December 20th next to communicate with Messrs. Johnson, Budd & Johnson, solicitors of the liquidators, 20, Austin Friars. After the date named, the liquidators will proceed to distribute the assets of the company.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the two weeks ending the 19th inst. were £2,950 and £1,614, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

6303. "Improvements in electrical indicators." B. J. B. MILLS. (Communicated from abroad by J. W. Howell, of America.) Dated May 10. 8d. Relates to certain improvements upon the electrical indicator set forth in provisional specification, No. 2630 of 1886; the object being to increase the convenience, economy, and accuracy of that instrument. The claims are 2 in number.

8181. "Improvements in electric clocks." J. G. LORRAIN. Dated June 21. 8d. Claims:—1. The improvement in electric clocks consisting of a train of wheels operating the hands and operated by an electro-motor, actuated by reversed currents, whose fixed part consists of an S-shaped magnet, substantially as set forth. 2. The improvement in electric clocks consisting in the combination of an electro-motor, actuated by reversed currents, and whose fixed part consists of an S-shaped magnet, and a mechanical brake, substantially as set forth.

8379. "Improvements in secondary batteries or electrical accumulators." A. RECKENZAUN. Dated June 25. 6d. Claim:—In the production of the plates of secondary batteries or electrical accumulators, the use or employment of small pieces of porous substances or materials embedded in molten metal and without necessitating the employment of perforated plates, grids, reticulated or other separate receiving and containing devices of any kind, substantially as herein set forth.

8758. "Improvements in electric arc lamps." L. HANSON. Dated July 5. 8d. The inventor employs an ordinary separating electro-magnet which attracts its armature on the completion of the circuit, and he also employs an ordinary electro-magnet shunt of high resistance for feeding the carbon. Instead of the carbon being connected to a rack and pinion and all the wheels accompanying such method, he dispenses with these and attaches the upper carbon to one end of a cord or string from which it is suspended, the other end of the said cord being attached to a weight or to a spring drum, but preferably a weight. Between the carbon and the weight, the cord passes over small pulleys and around a barrel carrying a spur wheel and a ratchet wheel, the said spur wheel gearing in a pinion, on the shaft of which is a brake pulley employed for purposes and actuated in the manner hereinafter described. According to the improvements there are only two wheels, consisting of a wheel and pinion, and these along with the brake pulley are carried by an oscillating frame hinged or pivoted on the top of a short pillar, which frame carries an armature. Therefore when the electro-magnet attracts the armature the hinged frame is attracted in such manner as to form an arc as the cord around the barrel is slightly drawn down, and as the carbon is being consumed the counter-balanced cord is allowed to descend at the same ratio as consumption, but no quicker as the armature attracted by the shunt magnet bears upon the periphery of the brake pulley and maintains the arc at one uniform distance, permitting the carbon to give off one uniform and steady light, but should the carbon break it would descend almost immediately and keep the light sustained until all the carbon is exhausted. The claims are 6 in number.

8994. "Improvements in automatic telegraphy and apparatus used therefor, parts of which are applicable to ordinary telegraphy." W. L. WISE. (Communicated from abroad by J. Rae and J. C. Simpson, both of Montreal.) Dated July 9. 8d. Has reference to the art of transmitting by telegraphy prepared messages, so as to be able to send in any given space of time a greatly increased number of words, and comprises new means of transmitting such messages, and also improvements in the apparatus to ensure the accuracy and clearness of messages sent at a high rate of speed. The messages are sent by the contact of the transmitting styluses alternately with the conducting surface of the revolving cylinder and the insulated spaces marked upon it, and that these may be worked either positively or negatively as desired. The claims are 11 in number.

9229. "Improvements in incandescent electric lamps and in the method of preparing and carbonising the conductors of such lamps." P. WARD. Dated July 15. 6d. Claim:—An electric incandescent lamp having a continuous carbon conductor, and the carbonising of the said conductor by a current of electricity of suitable magnitude, in the manner substantially as set forth and described.

9326. "An improvement in 'Morse inker' apparatus for 'telegraphic purposes.'" C. D. ABEL. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 17. 8d. Claim:—In combination with the armature lever of Morse inker apparatus, a capillary tube or wick dipping in an ink trough and surmounted by a marking roller, substantially as and for the purpose herein set forth.

9514. "Improvements in galvanic batteries." E. H. DESOLU. Dated July 22. 8d. Claims:—1. The addition of a second porous vessel in which is placed diluted sulphuric acid, intended to maintain at the same degree of acidulation, exterior and interior liquids preventing the polarisation of the battery. 2. The addition of a third porous vessel and of a second zinc element which added to the other zincs, increase the intensity in an electric battery. 3. The arrangement for the charging and discharging of the battery, without displacement, by the aid of pipes passing through the porous vessels. 4. The application of this same battery to galvano-plastic work, the elements being all united in quantity, that is to say, all the zincs together and all the carbons together.

10202. "Improvements in the manufacture of welded iron and steel tubes for telegraph poles and other poles and posts, for hollow shafts, and for other purposes." J. C. JOHNSON. Dated August 10. 8d. Claim:—Strengthening one or both ends of welded iron and steel tubes for telegraph poles and other poles and posts, for hollow shafts, and for other purposes, by the process of manufacture described and illustrated in the drawing; that is to say, taking a strip of the proper length, folding or doubling the end or ends, or a portion or portions of the sides of the strip upon the other portion so as to form a double thickness of metal for a length equal to the length of that portion or portions of the tube which is or are to be strengthened, bending the strip or plate heated to a welding heat into a tubular form, and welding its edges and the doubled or folded part or parts together, substantially as described and illustrated.

10680. "Improvements in completing electric circuits." P. EVERITT. Dated August 20. 11d. Consists in completing electric circuits by the combined application of a coin or the like, and the weight of the person wishing to make use of any appliance to which the invention is adapted. The claims are 3 in number.

13569. "Improvements in telephonic apparatus." J. S. ROSS. Dated October 23. 8d. Claims:—1. In a telephonic instrument the combination of a diaphragm unsecured at its edges with a spiral spring. 2. In a telephonic instrument the combination of a diaphragm unsecured at its edges with a spiral spring or its equivalent, the mechanical resistance of which may be regulated and adjusted. 3. In a telephonic instrument the combination of a collapsible or other form of diaphragm secured at its edges, or any other part, with a spiral spring or its equivalent. 4. In a telephonic instrument the combination of a collapsible or other form of diaphragm secured at its edges or any other part with a spiral spring or its equivalent the mechanical resistance of which may be regulated and adjusted. 5. The use of an arm or its equivalent, as and for the purposes shown.

14249. "Improvements in electrical fuses." G. SMITH. Dated November 5. 4d. Claim:—The application of the fuse composition in making electrical fuses in the form of an adhesive paste and without the ordinary paper tube substantially as described.

15888. "An improved process of repairing the filaments of electric glow or incandescence lamps." A. M. CLARK. (Communicated from abroad by C. Pauthonier, of France.) Dated December 4. 8d. Relates to the process described in the No. of the REVIEW for June 10th, 1887, page 540.

1887.

2835. "Improvements relating to electric batteries and to means for putting the same into and out of action." G. V. LAGARDE. Dated February 23. 11d. Relates to an improved single fluid electric battery provided with means for producing a constant circulation of the exciting fluid, for rotating the carbon electrodes, and for controlling the current from a point at some distance from the battery. The claims are 8 in number.

3125. "A new and improved method of and apparatus for electrically reproducing articulate speech and other sounds." W. D. HOUSE. Dated March 1. 8d. Consists, broadly, in causing electric currents, produced at the transmitter by the sounds to be conveyed, to set up molecular vibrations in an electrolytic vibratory body, located at the receiving station, which vibrations, imparted to the surrounding air, reproduce the original sounds. The claims are 9 in number.

4213. "An improved electric portable lamp." A. FRIEDLAENDER. Dated March 21. 8d. Consists chiefly of an immersion battery which provides the current for an incandescent lamp, the immersion device being so constructed that a minimum of space is required, and the battery can be put out of operation, or the strength of the current regulated by varying the depth of immersion, by operating the worm-spindle provided with suitable thumbpiece, or its equivalent, exteriorally of the battery case. The claims are 4 in number.

4527. "Improvements in electrodes applicable for use in primary or secondary batteries." L. EPSTEIN. Dated March 26. 8d. Claims:—1. Electrodes presenting the appearance of a grid railing or venetian blind, or of a sieve consisting of the active material, and a frame or support of lead, or some other suitable conducting material, substantially as described. 2. Electrodes presenting the appearance of a grid railing or venetian blind, or of a sieve consisting of the active material and conducting support or frame, and of a frame of some non-conducting material, substantially as described. 3. The manufacture of primary or secondary batteries with electrodes produced in the manner described, the manufacture of secondary batteries produced in the manner described.

4696. "Improvements in electric indicating or signalling apparatus." H. H. LAKE. (Communicated from abroad by J. T. Murray, of America.) Dated March 29. 8d. Has relation to electric indicators of that class wherein a series of two or more numbers or figures are indicated or caused to appear at a receiving station through the medium of electro-mechanical devices and electric currents, such numbers, figures, or letters indicating the station from which the signal is transmitted. The claims are 6 in number.

5293. "Improvements in horizontal governors especially adapted for electric motors." H. J. ALLISON. (Communicated from abroad by the Baxter Electric Manufacturing and Motor Company, of America.) Dated April 12. 8d. The object of this invention is to furnish a governor which remains substantially inoperative until the desired speed of the engine is attained, and which is susceptible of prompt action through its entire range of motion within a comparatively small range of variation above such normal speed. In the invention the centrifugal action of the governor is resisted by a spring, but as the resistance of the spring naturally increases with the expansion of the governor and its increased rate of speed, it is obvious that the movement of the governor is resisted with an increased force as it attains a higher speed of rotation; and such increased force would tend to prevent the free movement of the governor within a limited range above its normal velocity. To correct the increasing resistance of the spring, and to oppose the governor by a nearly uniform resistance, the inventor combines with the spring a weight opposing a gradually decreasing resistance, and makes the action of the weight adjustable, so that its effect upon the governor may be regulated at pleasure. The claims are 6 in number.

5328. "Improvements in electric and other clocks." A. L. PARCELLE. Dated April 12. 8d. The purpose of the invention is mainly to remedy such defects, and produce an electric clock of great uniformity, regularity, and certainty of action. With this object in view the inventor employs a resilient vibrator, which is flexible or elastic in its entire length. A pendulum of this character describes an approximately true cycloidal arc and is isochronous under such degrees of amplitude as are required for the operation of clock mechanism. The claims are 9 in number.

CORRESPONDENCE.

The Blackpool Electric Tramway.

I cannot allow the letter of "Manchester" to pass. I repeat that it was not my business to meddle with the engineer's arrangements regarding the insulators which I supplied for the Blackpool Tramway. It would have been sheer presumption on my part to have done so. I worked strictly to instructions and left the responsibility with others. Nevertheless, I had my opinions as to iron pins carrying copper rods, and I knew that bolts cemented firmly into earthenware cups would, if materially increased in temperature, bring about serious results. I did not know that there would be a combination of iron, copper, and salt water at work, but perhaps "Manchester" did, as he appears to have had a finger in the pie. However, I would only ask him what any practical telegraph engineers, thoroughly acquainted with the theory and practice of insulator construction, would have thought of all this? Evidently "Manchester" has not learned much after the event, for he is possessed of the common idea that glaze makes a good insulator, and actually infers that a portion of the insulator which is out of the direct path of the current should be glazed. The insulators which I supplied were not glazed at the ends, for manufacturing reasons, like the tops of all post-office insulators, but no doubt it is just about as important as brushing the cob-webs off the tramway before attempting to run a car. "Manchester" complains that the bolts were nearly through the insulators. If so, he must blame the specification and not me, but if about $\frac{3}{4}$ inch of solid porcelain is not enough for his engineering tastes (!) I should advise him to try blocks of granite or cast iron, well "glazed," of course. "Manchester" wishes to know if the insulators were tested "*after manufacture*." Perhaps he is one of those great scientists who would prefer to have them tested *before* manufacture. At any rate, he may get all the comfort he can out of Mr. Bryan's letter, appearing above his own in your last week's issue, wherein the insulators are stated to test perfectly (even with the glaze ground off) and to be of good quality.

Now *you* still appear to regard the breakdown as not being due to the insulators, but to expansion and contraction of the copper rods. I still maintain that the insulators are solely at fault, owing to defects in *design*. Mechanically speaking, the insulators would resist the expansion and contraction of any amount of tubes, for they are only connected to the latter by a small round wooden peg about 3 inches long by $\frac{1}{4}$ inch in diameter; in fact, this peg performs precisely the same function as a railway "key," but who ever heard of a "chair" being torn from the sleepers in consequence of expansion of the rail? Allowance is made at the fish plate joints for all this, and Mr. Holroyd Smith has done practically the same thing in making his tube joints in a similar manner. It therefore remains quite clear that the expansions of the *iron studs* themselves, and not the tubes, has split the insulators. The moment this takes place a terrific current runs through the inside of the insulator to earth, and "Manchester" may understand me better if I use the word of a Blackpool man, and say that "mortification" sets in immediately and clears all before it; but whether the studs split the insulators from atmospheric causes, or through the high electromotive force in the line, it is not for me to say. At any rate, whether the cups have split or not, the iron studs had so far corroded at the point of attachment as to render immediate renewal necessary, so that the breakdown was inevitable.

Mr. Bryan is quite right regarding the design of the insulator, for there is no provision for moisture, while pitch and tar, two indispensable conditions at Blackpool, could run down and cover the surface "glaze" and all, as "Manchester" is no doubt aware.

I am sending you one of the old insulators, and also a sample of the new insulator my firm is now making for the tramway, and from which you will, I feel sure, readily see the force of my remarks.

J. Slater Lewis.

August 24th, 1887.

Platinoid.

Mr. Swinburne's note in your last issue should not pass without reply, or some of your readers may be left in uncertainty as to the special claims of platinoid over German silver for electrical purposes. We should like to say very emphatically that it is not a matter of uncertainty whether tungsten is or is not used in the manufacture of platinoid, as we think Mr. Swinburne's note implies. It *is* used and *must be*. Platinoid cannot be produced without it. The problem, if problem there be, comes rather within the province of the metallurgist than that of the analytical chemist. The point in question was lucidly put in Mr. Bottomley's paper thus:—"The tungsten is added in the form of phosphide of tungsten, a considerable percentage of which is in the first place fused with a portion of the copper. The nickel is then added, and then the zinc and the remainder of the copper. The mixture requires to be re-fused more than once, and during the process the phosphorus and a considerable portion of the tungsten originally added is removed as scoriæ. In the end there is obtained a beautiful white alloy, which is platinoid. When polished the alloy is scarcely distinguishable in appearance from silver. To test the quality claimed for it as to being untarnishable, I have for some weeks been keeping ornamental specimens lying exposed to the ordinary town atmosphere, and I have satisfied myself that the alloy has a very remarkable power of resisting the tarnishing influence of the air of a large town."

Mr. Bottomley, writing his paper early in 1885, spoke cautiously. The alloy had only recently been invented. With two years' additional experience we may now confidently say that platinoid has so far shown that it possesses the power *absolutely* of resisting the tarnishing influence of the atmosphere. This is one of its peculiar merits. German silver cannot for a moment claim the same property, no matter how large may be the proportion of nickel it contains.

We cordially thank Mr. Swinburne for speaking of our platinoid wires in such appreciative terms. We wonder if he has ever found German silver yield such uniform results!

The London Electric Wire Company.

Electrical Tenders.

I have read with interest your article on the considerable differences in the tenders for the street alarms, &c., for the Hornsey Local Board. Though I do not pretend to solve the mystery, I may perhaps show reasons for the discrepancies.

First.—As you say, I have no doubt the specifications left a good deal to be desired in the matter of clearness, as I have often found, even with the largest and best informed firms who require tenders for electrical work, that there is an astounding ignorance concerning what will be best suited for their purpose. I have not unfrequently been able to supply a system which is much more suited to the purpose, and at a considerably less cost than I could have supplied what was originally asked for.

Secondly.—A firm with plenty of work, and which is not of a very enterprising disposition, will not take a new job unless it will answer their purpose, *i.e.*, unless they can make a really good thing out of it.

For instance, the Post Office charge very often twice as much for supplying telephonic communication to firms as many of the telephone companies do; though the P.O. is only able to supply a second class instrument; whereas the telephone companies are in a position to supply the very best.

Thirdly.—A firm with very little work in hand *may* be glad of a job if it will just pay, as they will not have to pay off their men as they otherwise would have to do.

A first-class firm has very often to charge more, as they make a practice of always putting in the very best work. A firm may be anxious for an advertisement and so may be ready to do the work for a mere nothing. There has been far too much of the latter kind of thing done in electrical work altogether. Some firms are able to supply as good an article as another at a much lower price owing to a large number of different circumstances, *i.e.*, good management, lower rates, lower wages paid, better machinery, more accustomed to deal with that class of work; nearly every firm has its speciality which it is able to supply at a lower rate than anyone else.

Moreover, there is a very large discrepancy very often in tenders whatever they are for. For instance, take the building of a house; surely this is no new trade like electrical work, and of all things for which the tenders might be expected to be reasonably close this holds out the greatest advantages.

For the architect knows what he does want, the plans and specifications are as clear as daylight, and moreover the quantity of every material required for the work is very frequently given, so there is no chance of the contractors differing in the quantity of material required. And yet even in this case the highest contract is sometimes twice as much as the lowest; how much more likely in anything connected with a new trade like electrical signals, &c.

I would not for a moment defend the discrepancies in the tenders. I think it is a bad sign, as showing that electrical work is not understood; but the above may give some idea how the differences arise.

A Practical Electrical Engineer.

Perhaps the mystery in connection with the tenders of the Hornsey fire alarm system is explained by the fact that the wire required is wrongly described in the specification, which reads thus—"The insulated wires for telephones to be No. 16 B.W.G. copper of not less than 95 per cent. conductivity, metallic circuit, insulated with best G.P., braided and ozokerited to No. 7 B.W.G."

It is evident that this should read, "Insulated with best G.P. to No. 7 B.W.G., and braided and ozokerited"; because, a wire with so small a covering as that indicated by the specification, would be a very delicate one for drawing into pipes, and nearly 20 miles of it could scarcely be maintained for £10 per annum.

But if used there will be a further chance for the electrical world, for, following the example of Glasgow, doubtless the second invitation will be to "tender for the removal of the system."

Wm. Clark Fisher.

August 23rd, 1887.

Incandescent Lamp Patents.

Unlike your correspondent Mr. W. Hamilton, I have not had the advantage of hearing the evidence in the case of Edison and Swan *v.* Shippey Bros., but I have the published records. With Mr. Hamilton I wish Mr. Shippey all success in his encounter with his heavy adversary, but I do not think any strengthening of the cause will result from perverting plain statements and obvious meanings. Nor is it becoming in Mr. Hamilton to gird at Drs. Hopkinson and Fleming and accuse them of carelessness and incompetent experiment. They are both of them men of established reputation and experimental physicists of the first rank, accustomed to tests conducted with such precautions, and attaining a degree of accuracy in the result that would be a revelation to the chemical part of Mr. Hamilton.

When Dr. Hopkinson said that the body of a certain filament after a certain treatment would still be carbon, of course he meant that its substance underwent no chemical change, and that the preponderating element is still carbon, and not that it might not contain a small percentage of foreign matter. We know very well that our currency is an alloy, but if Mr. Hamilton were to offer the Edison Company a sovereign for four or five of their lamps, would not he feel aggrieved on being told by an expert that the coin was not "broadly and substantially" gold? And Edison, it must be remembered, specifies amorphous filaments containing a presumably considerable amount of matter other than carbon though non-metallic and non-conducting.

"In applying the mercury test . . . . it was admitted that the mercury might have *contained occluded gases*. This shows that the most ordinary precautions were not observed." The special freeing of mercury from contained air is not an ordinary precaution, and even if it were, the omission of it could speak for nothing beyond itself. Clean mercury occludes, but an inconsiderable amount of gas and only a fraction, if any, of this could have been rendered free and visible under the circumstances of the test. But why take such pains to ruin one's own case. The greater the amount of gas freed from the mercury the better for Mr. Shippey, and the fewer the precautions taken to preserve the vacuum, the worse it is likely to be.

How your correspondent can "maintain" that the vacuum should have been tested hot, I fail to see. The question is an Edisonian vacuum which, according to No. 4,576 of 1879, is $\frac{1}{100\,000}$th of an atmosphere, and nothing is said about testing hot. We may question if Edison attained this, but his meaning is clear, for in a subsequent specification he says "as nearly perfect as possible, say $\frac{1}{300\,000}$th of an atmos." Recent experiments taken with abundant precaution show an attainable limit of $\frac{1}{4000}$th mm. pressure, that is $\frac{1}{304\,000}$th of an atmos. The lamp examined by Dr. Hopkinson had inside a pressure of nearly two millimetres of mercury, a degree of evacuation that can be obtained with the greatest ease. Mr. Hamilton's concluding sentence is vaguely suggestive. He says "one of the witnesses would not state that the filament *was* carbon, but only that he was of opinion that it was." Is there some dark hint of doubt here in the mind of the expert, or is your correspondent acquainted with people in whose minds opinions and beliefs are superseded by *absolute knowledge*. Happy man if he is. Let but one of them be retained for the defence, and the Edison-Swan experts and counsel may go, crowd into one of their own red hot crucibles and "have air blown upon them," for verily their occupation is gone.

D. S. Sinclair.

August 23rd, 1887.